East Hylebos Creek
2001 Monitoring Program

Final Report

July 2002

King County

Department of Natural Resources and Parks

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Cover photos (clockwise from upper left): Monitoring Station 0016, Monitoring Station 0006, Downstream from Monitoring Station 1, Monitoring Station 0015.

Executive Summary

The goal of the 2001 East Hylebos Creek Monitoring Program was to provide a general characterization of water quality, stream flow, and aquatic habitat conditions in the lower reaches of the East Hylebos Creek system. This information will eventually be used to update the Executive Proposed Basin Plan – Hylebos Creek and Lower Puget Sound (King County, 1991). In addition, this program complemented monitoring by the Hylebos Creek Stream Team and the City of Federal Way in the North and West Forks of Hylebos Creek. The monitoring program consisted of stage and flow monitoring at four stations, water quality sample collection during baseflow and storm events at four stations, benthic macroinvertebrate sampling in the ravine section of the mainstem of East Hylebos Creek, and a stream habitat survey of a portion of the ravine section.

The minimum baseflow observed during the summer months near the mouth of East Hylebos Creek was approximately 1 cfs and two of the upstream branches (tributary 0016 and tributary 0006) were dry during portions of the summer. During the winter months, flooding was observed near the mouth of the creek where the creek has historically overtopped the road.

Of the water quality parameters evaluated as part of this study, fecal coliforms, total phosphorus, copper, zinc, and total suspended solids were found to be parameters of concern in the East Hylebos watershed. Temperature, dissolved oxygen, and pH levels were within Washington Department of Ecology (Ecology) criteria. Fecal coliforms exceeded Ecology water quality criterion in almost all samples collected. Total phosphorus exceeded EPA recommended criterion for almost all samples except those collected during wet season baseflow conditions. Total suspended solids exceed King County's recommended basin threshold level during storm events near the mouth of East Hylebos Creek. Dissolved zinc and copper concentrations were higher than Ecology water quality criteria in tributary 0006 although these results are not directly comparable since the duration of sample collection stipulated in the Ecology standard is different than that used in this study. Water quality data from this study is similar to data presented in the *Current and Future Conditions Report* (1990) with the exception that fecal coliform concentrations may have increased.

Measurements of benthic invertebrates indicated some urbanization impacts, but the scores were relatively good compared to other sites sampled on the North and West Forks of Hylebos Creek. The ravine reach channel morphology has not undergone significant changes since the *Current and Future Conditions Report*. Channel structure at some of the upstream reaches is dynamic as shown by the significant change in channel morphology observed in tributary 0016.

Salmonid habitat is generally good in the ravine reach of East Hylebos Creek but is at risk for degradation from continuing upstream urbanization. All evaluated tributaries of East Hylebos Creek indicate that the creek continues to be impacted by urbanization in the watershed.

KING COUNTY
EAST HYLEBOS CREEK

2001 MONITORING PROGRAM

FINAL REPORT

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

The goal of the 2001 East Hylebos Creek Monitoring Program is to provide a general characterization of water quality, stream flow, and aquatic habitat conditions in the lower reaches of the East Hylebos Creek system. This information will be used to update the Executive Proposed Basin Plan – Hylebos Creek and Lower Puget Sound (King County, 1991). In addition, this program complements monitoring by the Hylebos Creek Stream Team and the City of Federal Way in the North and West Forks of Hylebos Creek.

The objectives for this project as stated in the *East Hylebos 2001 Monitoring Program Quality Assurance Project Plan* (QAPP) (Taylor Associates, Inc. 2001) were:

- Repeat selected monitoring activities done as part of the *Hylebos Creek and Lower Puget Sound Basins: Current and Future Conditions Report* (King County, 1990a).
- Have some collected data be comparable to data collected by Federal Way and the Hylebos Creek Stream Team on the North and West Forks of Hylebos Creek.
- Utilize new approaches to gather new information on conditions in East Hylebos Creek (e.g., benthic macroinvertebrate sampling).
- Have some components of the monitoring program able to be continued by volunteers.
- Provide useful information for updating the basin plan, specifically for salmon recovery with a focus on the ravine area (e.g., stream habitat survey).

The monitoring program consisted of the following four tasks:

Flow Monitoring. One continuous flow (and temperature) monitoring station was installed on the mainstem of East Hylebos Creek, and crest and staff gage monitoring stations were installed on three branches of East Hylebos Creek to monitor flow for a 13-month period with crest gages inspected monthly. Rating curves were developed, where possible, for each station.

Water Quality Sampling. Water quality samples were collected at the four monitoring stations at which flow monitoring was conducted. A baseflow dry season grab, a baseflow wet season grab, two storm event grabs, and two storm event composite samples were collected at each station.

Macroinvertebrate Sampling. Benthic macroinvertebrates were sampled in the ravine section of the main stem of East Hylebos Creek.

Stream Habitat Survey. Stream habitat was surveyed in a portion of the ravine section of the main stem of East Hylebos Creek.

In addition to providing a general characterization of conditions in the basin, parameters and protocols were selected to allow some comparison of results to data from other similar projects, regulatory requirements, or historical data. Due to the scope of this project and previously collected data, comparisons are not intended to be statistically valid. Where appropriate, water quality results are compared to Ecology water quality standards, to water quality data summarized in the *Current and Future Conditions Report* (King County 1990a), and to water quality data recently collected by the Hylebos Creek Stream Team on the North and West Forks of Hylebos Creek. Macroinvertebrate results will be compared to data collected by the Hylebos Creek Stream Team on the North and West Forks of Hylebos Creek. The stream habitat survey results will be compared to conditions summarized in the *Current and Future Conditions Report* and will be used to discuss the relevance/accuracy of the Ecosystem Diagnosis and Treatment (EDT) input data. EDT is a habitat-based procedure for relating environmental conditions to the performance of salmon populations. EDT analysis is currently being conducted by Pierce County for all of WRIA-10, including the Hylebos Basin.

Flow monitoring stations were established in late May 2001. Flow monitoring and crest gage readings began in June 2001 and continued through June 2002. The water quality samples were collected during this period. Macroinvertebrate sampling occurred during September 2001. The stream habitat survey was conducted during August 2001.

1.2 PROJECT BACKGROUND

The East Hylebos Creek drainage basin is located primarily in southwest King County and includes the East Hylebos Creek (tributary 0006) and its three major tributaries (0016A, 0016, 0015). In the upper portion of the basin, north of SR 161 (Enchanted Parkway), the tributaries flow over a relatively flat upland till surface. The tributaries combine south of SR 161 and flow through a long, steep gradient reach over Vashon advance outwash. The East and West Branches of Hylebos Creek converge within the broad floodplain of Lower Hylebos Creek near the King-Pierce County line to form the mainstem. Refer to the *Hylebos Creek and Lower Puget Sound Basins: Current and Future Conditions Report* (King County 1990a) for a more detailed description of the basin. The East Hylebos Creek drainage basin is shown in Figure 1 and Figure 2.

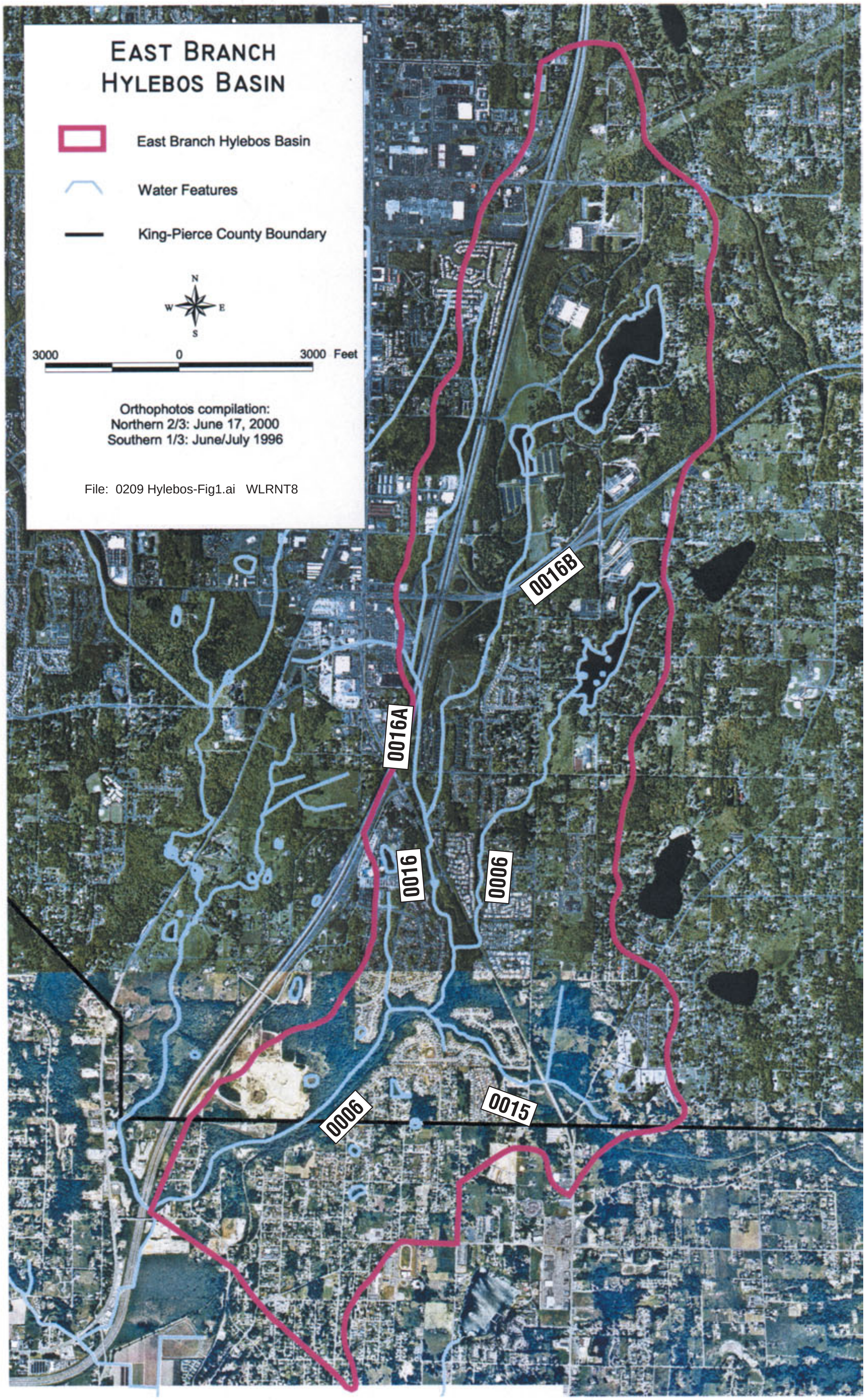

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Figure 1
East Hylebos Creek Drainage Basin

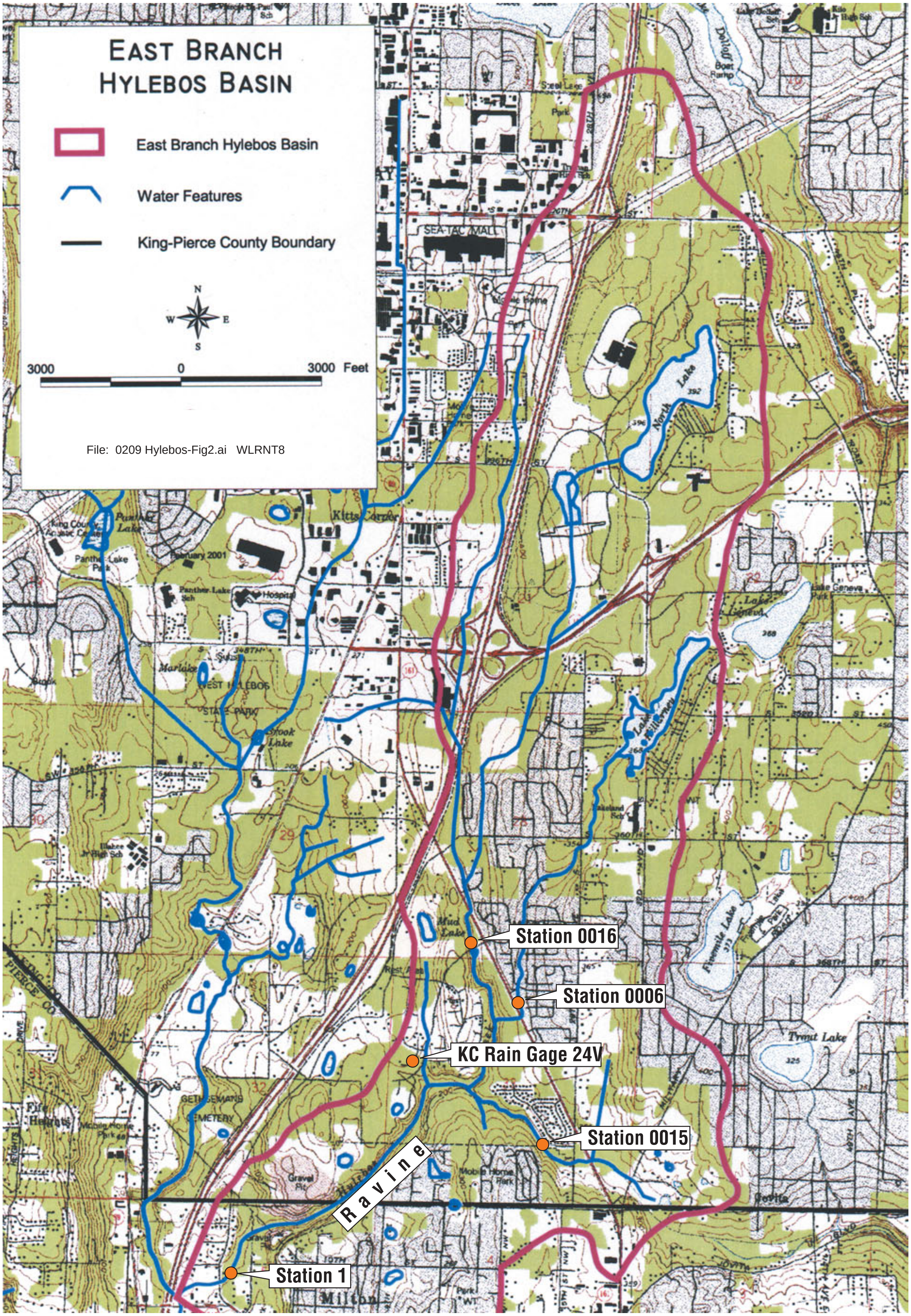

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Figure 2

East Hylebos Creek —
2001 Monitoring Locations

The *Current and Future Conditions Report* (King County, 1990a) includes a summary of current conditions and predicted future trends in East Hylebos Creek. In brief, the report identified stream reaches with high concentrations of pollutants and stream reaches experiencing or likely to experience flooding. East Hylebos Creek was in an urbanizing area and was experiencing increased flooding, habitat degradation, and water quality problems in various stream reaches. The *Executive Proposed Basin Plan: Hylebos Creek and Lower Puget Sound* (King County 1991) was produced in 1991 and assessed the conditions of aquatic systems in the basins, predicted future change based on development patterns, and recommended a variety of management tools to provide long-term stability and protection of significant beneficial uses.

The *East Hylebos Creek 2001 Monitoring Program Quality Assurance Project Plan (QAPP)* (Taylor Associates, Inc. 2001) was prepared by Taylor Associates, Inc. in conjunction with King County in June 2001. The focus of the 2001 East Hylebos Creek Monitoring Program was to provide new and updated information on the water quality and aquatic habitat conditions in the lower reaches of the East Hylebos Creek system, especially as it relates to salmon habitat. This final report presents results of the monitoring described in the QAPP. For reference, the QAPP (minus its appendices) is in Appendix A.

2.0 DATA COLLECTION METHODS

This section presents a summary of the experimental design and data collection methods used on this project. For a more detailed description of field methods related to these items, refer to the QAPP (Appendix A).

2.1 FLOW AND RAINFALL MONITORING

The purpose of stage, flow and rainfall data collection was to provide some basic data on the flow regime of the stream reaches evaluated (e.g., ephemeral, peak stages, general magnitude of flows) and to enable the flow-weight compositing of water quality samples during selected storm events. There were four monitoring stations on East Hylebos Creek (Figure 2). A photo of each of the four stations is shown on the cover of this report.

Monitoring Station 1 is located on the main stem of East Hylebos Creek (tributary 0006) downstream of the ravine area, immediately upstream of the 5th Avenue overpass. This site was previously a USGS flow gaging station and a staff and crest gage were already installed. Water quality samples were collected at this location as part of the 1987-1988 METRO baseflow study discussed and described in Section 4.1 of this report. Monitoring Station 1 was referred to as QEH1 in the METRO study. Taylor Associates installed a staff gage and a Sequoia Scientific, Inc. Aquarod two-meter capacitance probe. Water and water temperature data were logged on a 15-minute data interval and downloaded approximately monthly. A crest gage was not installed at this location since the Aquarod logged continuous water level data.

The photo in the lower right corner on the cover shows the culvert outlet and a portion of the creek downstream of Station 1.

The other three stations are located above the ravine on branches of East Hylebos Creek near their confluence with the main stem. Monitoring Station 0015 is located on tributary 0015 off the access road at 380th Street just south of the Enchanted Parkway. A previously used staff gage was present at this location. Taylor Associates installed a new staff gage with an associated crest gage at this location. The photo in the lower left corner on the cover shows Station 0015.

Monitoring Station 0006 is located on tributary 0006 approximately ten feet downstream from where it passes under 370th Street, just to the north of the Enchanted Parkway. Station 0006 is approximately 9000 feet upstream of Station 1. Taylor Associates installed a staff gage with an associated crest gage at this location. The photo in the upper right corner on the cover shows Station 0006.

Monitoring Station 0016 is located on tributary 0016 approximately twenty feet upstream of where it passes under 19th Way South. A previously installed staff gage was present at this location. Taylor Associates installed a new staff gage with an associated crest gage at this location. The photo in the upper left on the cover shows Station 0016.

Monthly site visits were made to measure and reset crest gages and download the Aquarod. Staff gage readings were recorded during each monitoring station visit. Where feasible, rating curves were developed for each of monitoring stations based on five flow measurements using a Swoffer flow meter at an appropriate stream cross-section near each station. Rating curves were developed using a best fit curve in Excel. Flow monitoring was conducted from June 1, 2001 through July 12, 2002.

Rainfall was recorded at 15-minute intervals at King County Precipitation Gage 24V located along East Hylebos Creek (Figure 2). Rainfall data was downloaded from the King County web site (http://dnr.metrokc.gov/hydrodat/index.htm) or provided by King County at the end of the project for the period June 1, 2001 through July 12, 2002.

2.2 WATER QUALITY SAMPLING

Water quality sampling was conducted at the four monitoring stations (Monitoring Station 1, Monitoring Station 0015, Monitoring Station 0006, and Monitoring Station 0016) described in Section 2.1.

A baseflow dry season grab sample, a baseflow wet season grab sample, two storm event grab samples, and two storm event composite samples were collected at each of the four stations. Staff gage readings and water quality measurements with hand-held instruments were made when grab samples are collected. The parameters for this study included total suspended solids (TSS), turbidity, total phosphorus (TP), total and dissolved copper, total and dissolved zinc, hardness, fecal coliform, total petroleum hydrocarbons (TPH), conductivity, dissolved oxygen, pH, and temperature. Since not all parameters are pollutants of concern for both baseflow and storm events, an appropriate subset of the above parameters were measured during each sampling event. The field measurements and parameters for laboratory analysis for each sample type are found in Table 1 of the QAPP (Appendix A). Parameters, sample container material, analytical methods, reporting limits, units, preservation methods, holding times and required volumes for laboratory analysis for these parameters are summarized in Table 2 of the QAPP (Appendix A). King County Environmental Laboratory performed the laboratory analyses.

Due to the abundant rainfall and the availability of the laboratory to accept samples, the antecedent dry period and predicted storm depth for sample collection were revised from the criteria originally presented in the QAPP to more realistic values that still met the needs of the project (Table 1).

Table 1. Updated Antecedent Dry Period and Predicted Storm Depth Criteria for Base Flow and Storm Event Sampling

	Antecedent Dry Period	**Predicted Storm Depth**
Base Flow - updated	<0.05" in 72 hrs	0.0"
Base Flow - previous	7 days	0.0"
Storm Events - updated	< 0.1" in 48 hours	> 0.2" in 24 hours
Storm Events - previous	< 0.1" in 72 hours	> 0.2" in 24 hours

The procedures for baseflow grab sample collection, storm event grab sample collection, and storm event composite sample collection are summarized in Section 2.2.2 Water Quality Sampling of the QAPP (Appendix A). The field measurement and water quality sample collection procedures that are detailed in the QAPP were followed except as mentioned below.

The original intent was to collect grab samples at all four monitoring stations during a single sampling event. However, during the first storm event grab sample collection on October 10, 2001 there was no flow at Station 0016. Thus, a storm event grab sample was collected for this station during a storm on May 27, 2002 during which no other stations were sampled.

For the composite storm events, six grab samples were collected approximately hourly at each station during each storm event. For each station, three samples were submitted to the laboratory for analysis: (1) the first grab sample (analyzed for NWTPH-Dx and fecal coliform), (2) the "most polluted" grab sample of the six collected based on visual inspection and conductivity measurements (analyzed for all parameters except NWTPH-Dx and fecal coliform), and (3) the storm flow-weighted composite sample prepared by Taylor Associates form the six grab samples prior to delivering the samples to the laboratory (analyzed for all parameters except NWTPH-Dx and fecal coliform). The six grab samples were composited using the stage readings observed at the time of grab sample collection and the stage-discharge relationships for each station developed as part of the flow monitoring element of the project. However, at Station 0006, a rating curve was unable to be developed, and the compositing assumptions for the six samples from this station during each composite storm event are described Section 3.1.4.

Water quality samples were identified as follows:

Station # (1, 0006, 0015, 0016) - Date (month/day/year) – Type of Sample

The abbreviations for Type of Sample are as follows:

DSBF – dry season base flow grab sample
WSBF – west season base flow grab sample
SG – storm grab sample
SC – storm composite sample
SC – MP – most polluted grab sample from the six grab samples collected for the storm composite sample. The most polluted sample was selected based on visual observation and/or conductivity measurements.

For example, the dry season base flow sample collected at Station 1 on May 5, 2002 was identified as:

Station 1 – 050502 – DSBF

Water quality data collected as part of this study is stored in the King County LIMS database. The King County Environmental Laboratory used KC LIMS database Locators assigned to the monitoring stations to identify each station as shown in Table 2.

Table 2. Crosswalk between Monitoring Station Numbers and KC LIMS Locators

STATION	KC LIMS LOCATOR	ADDRESS
Monitoring Station 1	B920	5th Ave and Trib 0006
Monitoring Station 0016	F920	19th Way So. And Trib 0016
Monitoring Station 0006	G920	So. 370th and Trib 0006
Monitoring Station 0015	H920	So. 380th and Trib 0015

2.3 MACROINVERTEBRATE SAMPLING

Site selection was guided by the intent to characterize biological integrity in the ravine reach. A benthic macroinvertebrate sample was collected on September 12, 2001 upstream of the wetland located at the downstream end of the ravine section of the main stem of East Hylebos Creek (Figure 2). In the QAPP, it was proposed that benthic macroinvertebrate samples be collected at two locations: one downstream and one upstream of the wetland. However, based on the results of the habitat survey, it was determined that the channel structure below the wetland was not appropriate for benthic macroinvertebrate sample collection due to the sandy substrate and uniform channel structure (i.e., no riffles).

The benthic macroinvertebrate sample was collected using protocols set forth by King County in *Field Protocols for Benthic Macroinvertebrate Sampling for Use With the Benthic Index of Biotic Integrity 2000* (King County 2000). The benthic sample was a composite of samples collected from three riffles randomly selected from the 35 riffles identified as part of the habitat survey. At each of the three riffles, three samples were collected using a modified Hess sampler (0.1 m^2, 500 micron mesh). As part of the macroinvertebrate sampling process, habitat data in the vicinity of the sample locations was recorded on forms from the *Rapid Bioassessment Protocols (RBP) for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition* (Barbour et al. 1999). Macroinvertebrate samples were shipped to EcoAnalysts, Inc. for analysis. For details of the sampling methods and laboratory analysis refer to Section 2.2.3 Macroinvertebrate Sampling of the QAPP (Appendix A).

2.4 STREAM HABITAT SURVEY

The stream habitat survey was conducted on August 27th and 29th, 2001. Approximately 3500 feet of the approximately 5000 feet of ravine reach of the main branch of East Hylebos Creek was surveyed (Figure 2). The survey began at the lower end of the ravine and worked upstream. Although not surveyed, the 1500 feet of the upstream ravine reach was walked, and habitat quality was observed to be similar to that observed in the lower ravine reach surveyed. The methods for the survey followed those outlined in *Inventory Methods for Wadable Streams in King County* (King County 2001). In brief, working upstream each habitat unit was classified first as a pool, riffle, or side-channel and noted in the HabID column as P1, R1, P2, R2, S1…Pn, Rn, Sn. Pools were determined by visual observation of function using habitat types described in McCain. et al. (1990). The minimum size qualification for LWD was 2 meters, and LWD was grouped into three diameter classes (Table 3). Bankfull width was measured at each habitat unit except for pools. Riparian vegetation for each stream bank was identified by type, size and density at each habitat unit, 100 feet perpendicular to the habitat unit. Due to the difficulty in carrying survey equipment through difficult terrain in addition to other field gear required for the stream habitat survey, gradient was calculated using data from Topo! Software. Substrate size was determined from a Wolman pebble count at two locations (100 pebbles at each location). A complete description of the field methods used for the Stream Habitat Survey is in Section 2.2.4 Stream Habitat Survey of the QAPP (Appendix A).

Table 3. LWD Diameter Classes

Diameter Class	Diameter (inches)	Diameter (cm)
Small	4-12	10-30
Medium	12-20	30-50
Large	20+	Greater than 50

3.0 RESULTS

3.1 FLOW AND RAINFALL MONITORING

The results of the flow and rainfall monitoring are presented in this section including rating curve development for each station, monthly staff and crest gage readings, continuous data from Station 1, and stage and flow data from storm events sampled for water quality.

3.1.1 Rating Curves

Rating curves were developed for the Stations 0001, 0015, and 0016. The rating curves were developed to provide an estimate of flow during sampling events and monthly peak flows. The rating curves met the needs of this study, however, the accuracy of the rating curves were affected by several factors. Rating curves were developed from five flow measurements at the beginning of the study, unless otherwise noted. With the exception of Station 0016, rating curves were not updated although minor changes in channel morphology may have occurred. Flow was extrapolated based on extending the rating curve using the equation developed for measured data flow points, both above and below the highest and lowest measured flow rates, respectively. The stage and flow measurements used to develop the rating curves along with stage discharge equations and graph are included in Appendix B.

The Station 0001 rating curve was developed based on five flow measurements. The lowest flow measured used to develop the rating curve was 1.17 cfs which corresponded to the staff gage reading and water depth of 0.58 feet. The highest flow measured used to develop the rating curve was 24.1 cfs which corresponded to the staff gage reading and water depth of 2.94 feet. Flow was extrapolated both above and below the highest and lowest measured flow rates for this study, respectively. Also, as discussed with King County, the rating curve developed at this location is not accurate at higher flows due to backwater conditions. However, this was the most suitable location for flow monitoring in the lower reach of East Hylebos Creek found during field visits and in discussions with King County. Based on field observations it was estimated that backwater conditions began influencing flow at a stage of approximately 2.7 feet. The water level rises above the crown of the culvert immediately downstream of Station 1 and floods the road at least annually. The culvert crest is located at approximately 4.1 feet.

At Station 0016 two rating curves, pre- and post- channel change, were developed due to a significant change in channel structure observed after the large November 14, 2001 storm. During the November 14th storm, several pieces of large woody debris were transported down the channel and lodged at the entrance to the culvert immediately downstream of the gaging station. This event caused the stream channel geometry to change significantly. The location of the low flow channel shifted, the pool area where the staff gage is installed became a riffle, and the left stream bank immediately upstream of the culvert was eroding. The stream bed level at the staff gage increased approximately 0.6 feet after the storm event. Since December 2001, the stream bed level has remained relatively stable.

Thus, the three flow measurements taken prior to November 15th were used to develop the pre-channel change rating curve for Station 0016. The pre-channel change rating curve was used to convert stage measurements to flow between June 1, 2001 and November 14, 2001. The lowest flow measured used to develop the pre-channel change rating curve was 0.09 cfs which corresponded to the staff gage reading of 4.81 feet and a water depth of 0.81 feet. The highest flow measured used to develop the pre-channel change rating curve was 24.1 cfs which corresponded to the staff gage reading of 5.18 feet and water depth of 1.18 feet. Flow was extrapolated both above and below the highest and lowest measured flow rates for this study, respectively.

Five flow measurements from a single storm were used to develop the post-channel change rating curve for Station 0016. The post-channel change rating curve was used to convert stage measurements to flow between November 15, 2001 and June 31, 2002. The lowest flow measured used to develop the post-channel change rating curve was 4.54 cfs which corresponded to a staff gage reading of 5.00 feet and a water depth of 3.82 feet. The highest flow measured used to develop the post-channel change rating curve was 23.2 cfs which corresponded to the staff gage reading of 5.49 feet and water depth of 0.81 feet.

At Station 0015 a rating curve was developed based on five flow measurements. Flow was extrapolated both above and below the highest and lowest measured flow rates, respectively. The lowest flow measured used to develop the rating curve was 0.05 cfs which corresponded to a staff gage reading of 3.47 feet and a water depth of 0.17 feet. The highest flow measured used to develop the rating curve was 8.70 cfs which corresponded to the staff gage reading of 4.17 feet and a water depth of 0.87 feet. Flow was extrapolated both above and below the highest and lowest measured flow rates for this study, respectively.

A rating curve could not be developed for Station 0006 due to a combination of factors. During the summer season, the station was dry. During smaller storms, there was no measurable velocity and during larger storm the flow left the channel and expanded into the adjacent floodplain making flow measurements impossible. Thus, only stage readings are available for Station 0006.

3.1.2 Monthly Staff and Crest Gage Readings and Flow Conversions

Monthly staff gage readings, crest gage readings, and flow conversions for the four stations are presented in tables for each station in Appendix C. Flow rates calculated from monthly staff gage and crest gage readings are presented in Table 4. Note that peak flow calculations were often based on extrapolations outside the highest measured flow of the rating curve. Crest gage readings for Station 0001 were based on Aquarod measurements during the corresponding month. No flow conversions are presented for Station 0006 as a rating curve could not be constructed (see discussion in Section 3.1.1).

The upstream tributaries were dry during portions of Summer 2001. Station 0006 was dry during the July monthly visit, and standing water was present during the August and September monthly visits. Station 0015 was dry during the July, August, and September monthly visits, and standing water was observed during the October monthly visit. Station 0016 was dry during the July monthly visit, and standing water was observed during the August site visit.

Station 0015 crest gage data from August 29, 2001 seems abnormally high compared to data collected at other stations during the same period and compared to other crest gage flows at the Station 0015 during the year. However, the data has been entered correctly from the field data sheet. Thus, the data is flagged but still reported in Table 4.

Table 4. Flow Rates Calculated from Monthly Staff Gage and Crest Gage Readings

	Station 1		Station 0006[1]		Station 0015		Station 0016	
Date[2]	Gage (cfs)	Crest (cfs)	Gage (ft)	Crest (ft)	Gage (cfs)	Crest (cfs)	Gage (cfs)	Crest (cfs)
6/28/2001	3.3	26	3.65	4.79	0.88	11	0.80	54
7/27/2001	1.1	2.6	dry	3.72	dry	2.2	dry	1.2
8/29/2001	1.1	11	dry	4.61	0	63[3,8]	dry	4.1
9/28/2001	1.2	1.8	dry	4.48	0	3.4	0.02	0.14
10/31/2001	6.6	8.7	3.91	4.67	1.5	6.6	2.0	9.0
11/30/2001	15	39	4.41	5.19	2.9	41[8]	5.0	-[4]
12/25/2001	5.0	-[5]	4.41	5.09	1.4	10	4.7	53[8]
1/29/2002	7.6	-[5]	4.36	4.88	1.7	11	5.0	40
2/26/2002	7.6	-[5]	4.36	4.75	1.7	11	4.7	34
3/31/2002	4.2	-[5]	4.16	4.73	0.93	16	2.6	37
4/30/2002	3.3	-[5]	3.99	4.83	0.82	21	1.6	44
5/27/2002	2.1	-[5]	4.03	4.29	0.62	5.0	0.01	2.6
7/12/2002	1.8	15[6]	dry	4.54	0.14	1.2	0	-[7]

[1] Staff gage readings (i.e., not flow rates) are reported (and shown in shaded cells) for Station 0006 since a rating curve could not be developed. Water depth = Staff Gage Reading – 3.30'.

[2] Date is the day of the site visit on which the staff and crest gage readings (which are converted to flow in this table) were taken.

[3] This crest gage reading seems abnormally high. However, the data has been entered correctly from the field data sheet. Thus, the data is flagged, but still reported.

[4] There is no crest gage reading for Station 0016 since almost all the cork was flushed from the crest gage, most likely during the November 14th storm event which caused significant change in channel structure at the station.

[5] No crest stage readings for this period due to sediment accumulation around the equipment.

[6] Crest gage reading taken on July 12, 2002 was for the period June 12, 2002 - July 12, 2002.

[7] No crest stage readings available for this date due to equipment vandalization.

[8] This flow rate is qualified since it is greater than two times the highest flow measurement used to develop the stage-discharge curve.

3.1.3 Continuous Station 1 Data and Rainfall Data

Monthly graphs of continuous stage and water temperature measurements from Station 1 are presented in Appendix D. Sediment accumulation in the Aquarod housing affected performance of stage recording from approximately December 25, 2001 to June 12, 2002. Sediment accumulated in the housing dampened the response time of the Aquarod during this period.

During rapid level changes (i.e., during rainfall events), water level in the capacitance rod did not rise and fall at the same rate and to the same levels as in the stream. However, level and flow data from this period has been included in Appendix D since the low water levels recorded during dry periods may provide some indication of minimum water level since the water level in the capacitance probe may have had enough time to equilibrate. Temperature data, for the same reason, may also not be accurate but was included to provide a rough estimate of water temperatures during this period.

Hourly rainfall totals from King County Rain Gage 24V are also shown on these graphs. Final data (i.e., data that has been reviewed by King County) was available from June 1, 2001 through September 30, 2001. Provisional data (i.e., data that has not been fully evaluated and/or corrected by King County) was available from October 1, 2001 through June 25, 2002 at the time this report was produced.

3.1.4 Stream Flow and Rainfall Data for Storm Events

This section includes a brief description of the stream flow and rainfall data associated with each sampling event. Since rainfall data from KC Gage 24V was not available in real time, rainfall data from SeaTac airport was used to determine whether antecedent dry period criteria had been met. As a result, rainfall data from KC Gage 24V sometime indicated that the antecedent dry period criteria had not been met. However, all antecedent dry period criteria were determined sufficient for this study as discussed below. Rainfall data from KC Gage 24V and periods of sample collection are shown in the graphs in Appendix D. Staff gage readings and flow rates at each station during sample collection events are summarized in Table 5.

Table 5. Water Quality Sample Collection – Stage and Flow

		Station 1		Station 0006	Station 0015		Station 0016	
Sample Event	Date	staff gage (ft)	flow (cfs)	staff gage (ft)	staff gage (ft)	flow (cfs)	staff gage (ft)	flow (cfs)
WSBF	2/4/02	1.56	5.95	4.36	3.83	1.33	5.00	4.42
DSBF	5/13/02	0.86	2.20	3.71	3.67	0.46	4.77	0.40
SG#1	10/10/01	0.60	1.20	4.08	3.72	0.67	-	dry
SG#1[1]	5/27/02	-	-	-	-	-	4.68	0.00
SG#2	1/07/02	4.00	28.84	4.66	4.18	5.96	5.60	32.80
SC#1 - 1	2/21/02	1.95	8.65	4.59	4.04	3.57	5.01	4.68
SC#1 - 2	2/21/02	2.61	14.10	4.55	4.1	4.50	5.09	7.07
SC#1 - 3	2/21/02	2.9	16.83	4.56	4.11	4.67	5.24	12.78
SC#1 - 4	2/21/02	3.1	18.82	4.56	4.14	5.20	5.34	17.46
SC#1 - 5	2/21/02	3.3	20.89	4.6	4.17	5.76	5.37	19.00
SC#1 - 6	2/21/02	3.46	22.62	4.56	4.17	5.76	5.48	25.16
SC#2 - 1	4/9/02	1.07	3.17	4.20	3.84	1.41	4.89	1.99
SC#2 - 2	4/9/02	1.10	3.32	4.19	3.81	1.19	4.91	2.36
SC#2 - 3	4/9/02	1.16	3.62	4.10	3.80	1.12	4.91	2.36
SC#2 - 4	4/9/02	1.24	4.05	4.05	3.78	0.99	4.91	2.36
SC#2 - 5	4/9/02	1.25	4.11	4.01	3.78	0.99	4.91	2.36
SC#2 - 6	4/9/02	1.23	4.00	4.00	3.78	0.99	4.91	2.36

[1] The Station 0016 storm grab was collected at a different date than the other stations. Staff gage readings are readings from the staff gage at that location, not actual water depths.

The wet season baseflow grab sample (WSBF) was collected on February 4, 2002 between 14:50 and 16:00 (PST). During the 72-hour antecedent dry period, 0.08 inches of rainfall was recorded at KC Rain Gage 24V between February 2, 21:00 and February 3, 15:00. The hourly rainfall totals during this event were less than or equal to 0.02 inches. This slightly exceeds the antecedent dry period criteria for this study. Due to the relatively minor exceedance of the antecedent dry period criteria and the low intensity showers during this period, the WSBF sample is accepted as a representative baseflow event.

The dry season baseflow grab sample (DSBF) was collected on May 13, 2002 between 10:10 and 11:40. During the 72-hour antecedent dry period, no rainfall was recorded at KC Rain Gage 24V. The most recent recorded rainfall was 0.01 inches on May 10, 2001 at 1:00.

The first storm event grab sample (SG#1) was collected on October 10, 2001 between 9:40 and 11:00. During the 48-hour antecedent period, 0.23 inches of rain fell between 15:00 and 18:00 on October 8th. This exceeded the 0.1-inch antecedent dry period criteria for the storm event. However, since the rainfall event occurred at the beginning of the 48-hour antecedent period, the SG#1 was accepted as a representative storm event. The total rainfall depth of the storm sampled was 0.41 inches. The sample was collected during the beginning of the storm event after approximately 0.1 inches of rainfall had occurred in the previous three hours with maximum hourly rainfall intensity during this period of 0.06 inches.

There was no flow at Station 0016 during the October SG#1 sample collection. Thus, a storm event grab sample was collected for this station during a storm event on May 27, 2002 at 19:30 and included with the SG#1 data. During the 48-hour antecedent period, 0.01 inches of rain fell. Total storm rainfall depth was 0.21 inches. The sample was collected during the middle of the storm event after approximately 0.1 inches of rainfall had occurred in the previous three hours with maximum hourly rainfall intensity during this period of 0.05 inches.

The second storm event grab sample (SG#2) was collected on January 7, 2002 between 8:15 and 10:00. During the 48-hour antecedent period, 0.04 inches of rain fell. Total storm rainfall depth was 1.46 inches. The sample was collected during the middle of the storm event after approximately 0.82 inches of rainfall had occurred with maximum hourly rainfall intensity during this period of 0.15 inches.

The first storm event composite sample (SC#1) was collected on February 21, 2002 between 2:00 and 9:00. During the 48-hour antecedent period, 0.25 inches of rain fell between 2:00 and 15:00 on February 19th. This exceeded the 0.1-inch antecedent dry period criteria for storm events. However, since the rainfall event occurred at the beginning (i.e., first 13 hours) of the 48-hour antecedent period, this storm event was accepted as a representative storm event. Total storm depth was 0.83 inches over 13 hours. A grab sample was collected at each station approximately hourly for five hours during the storm event which had a maximum peak hourly rainfall intensity of 0.14 inches per hour. Data sheets documenting volumes used for compositing and the selection of the most polluted sample (SC#1–MP) are included in Appendix E. The most polluted sample was selected based on visual observations and/or conductivity measurements. The selection of the most polluted sample is an attempt to analyze the grab sample with potentially the highest concentrations of pollutants.

The second storm event composite sample (SC#2) was collected on April 9, 2002 between 7:00 and 13:00. During the 48-hour antecedent period, there was no rainfall. Total storm depth was 0.19 inches over a seven hour period. The sample was collected throughout the storm event, which had a maximum peak hourly rainfall intensity of 0.06 inches per hour. Data sheets documenting volumes used for compositing and the selection of the most polluted sample (SC#2–MP) are included in Appendix E.

3.2 WATER QUALITY SAMPLES

Water quality results from storm events and associated QA/QC results are presented below.

3.2.1 Water Quality Results from Storm Events

Laboratory water quality results and field measurements from each of the sampling events are presented in Table 6. The laboratory also analyzed samples for nitrite-plus-nitrate nitrogen and total and dissolved arsenic, barium, chromium, cobalt, lead, nickel, thalium, and vanadium. The laboratory results are in Appendix E, but this data is not discussed within the scope of this report.

During the sample collection from the first storm grab event on October 10, 2001 there was no flow present at Station 0016. To complete the data set, a storm event grab sample was collected only at Station 0016 on May 27, 2002.

The field conductivity meter was not functioning properly during the dry season baseflow event (DSBF) based on comparison with laboratory analyses. In addition, the conductivity data from the SG#1 sampling event appear to be too high, indicating equipment error. This data is qualified and included in Table 6 but is not discussed in the report. The average value of duplicate samples (i.e., when two samples were collected at one location during a sampling event for QA/QC purposes) is used for discussion purposes in this report.

3.2.2 QA/QC Results

Quality control samples for laboratory and field activities were collected. A detailed discussion of the QC samples and associated frequency and acceptance criteria are presented in Section 2.5.1 of the QAPP (Appendix A). Results of the QC samples are included in the laboratory water quality reports in Appendix E.

Table 6. Water Quality Results

Event	Sample ID	KC Locator	Lab ID	Laboratory: Total Suspended Solids	Turbidity	Total Phosphorus	Hardness, Calc	Copper, Dissolved, ICP-MS	Copper, Total, ICP-MS	Zinc, Dissolved, ICP-MS	Zinc, Total, ICP-MS	Fecal Coliform	Diesel Range (>C12-C24)	Lube Oil Range (>C24)	Conductivity	Dissolved Oxygen (Winkler)	pH	Field: Temperature	Conductivity	Dissolved Oxygen	pH
			units	mg/L	NTU	mg/L	mg CaCO3/L	mg/L	mg/L	mg/L	mg/L	CFU/100ml	mg/L	mg/L	umhos/cm	mg/L	pH	C	mS/cm	mg/L	pH
			MDL	0.5	0.5	0.005	0.2	0.0004	0.0004	0.0005	0.0005	-	0.2	0.2	0.5	0.5					
			RDL	1	2	0.01	1.25	0.002	0.002	0.0025	0.0025	-	0.2	0.2	10	1					
WSBF 02/04/02	Station1-020402-WSBF	B920	L23193-1	2.89	3.37	0.036	45.5	*0.0016*	0.00205	0.00311	0.00475	45						5.04	0.128	13.20	7.34
	Station1-020402-WSBF-DUP	KCO	L23193-5	*0.93*	5.39	0.026	53.4	*0.001*	*0.0012*	0.00357	0.00453	4			133	11.5	7.38	5.04	0.128	13.20	7.34
	Station0006-020402-WSBF	G920	L23193-2	ND	3	0.013	16.8	*0.00091*	*0.001*	0.00845	0.00999	3						5.12	0.054	13.13	7.25
	Station0015-020402-WSBF	H920	L23193-3	*0.95*	7.66	0.022	56.2	*0.001*	*0.0013*	0.00352	0.00458	3						5.60	0.140	12.60	6.67
	Station0016-020402-WSBF	F920	L23193-4	2.42	4.25	0.041	28.7	0.00251	0.00305	0.00391	0.00568	3300						5.20	0.098	13.36	7.30
DSBF 05/13/02	Station1-051302-DSBF	B920	L24039-1	2.2	*0.92*	0.065	85	*0.00055*	*0.0007*	*0.001*	*0.0014*	30			208	10.8	8.07	10.65		11.36	7.65
	Station0006-051302-DSBF	G920	L24039-2	*0.62*	*0.84*	0.476	82.5	ND	*0.0012*	0.0117	0.0167	76			192			11.60		7.98	7.44
	Station0015-051302-DSBF	H920	L24039-3	4.53	4.28	0.05	67.3	*0.00055*	*0.00091*	0.00374	0.00563	160			165			11.06		10.56	7.37
	Station0016-051302-DSBF	F920	L24039-4	1.73	*1.6*	0.105	41.3	0.00259	0.0033	0.0125	0.0156	130			153			11.99		10.69	7.54
SG#1 10/10/01	Station1-101001-SG	B920	L22337-1	2.86	*1.7*	0.051	97.4	*0.00046*	*0.00048*	*0.0011*	*0.0015*	740	ND	ND				8.50	0.303*		7.63
	Station1-101001-SG-DUP	(B920)	L22337-5	2.55	*1.8*	0.052	95.1	ND	*0.00051*	*0.00087*	*0.0016*	780	ND	ND				8.50	0.303*		7.63
	Station0006-101001-SG	G920	L22337-2	4.79	5.22	0.075	8.09	0.00296	0.0044	0.085	0.0935	3700	ND	0.3				10.80	0.024*		6.43
	Station0015-101001-SG	H920	L22337-3	9.69	9.44	0.078	10.6	*0.0018*	0.00297	0.0108	0.0179	1300	ND	0.28				9.70	0.308*		7.18
5/27/02	Station 0016 - 052702 - SG	F920	L23900-1	4	4.11	0.078	45.2	0.00262	0.00315	0.00784	0.0111	320	ND	ND				14.84	0.335*		6.93
SG#2 1/7/02	Station1-010702-SG	B920	L22882-5	26.3	31.5	0.1	29.7	0.00247	0.00517	0.00303	0.0103	350	ND	ND				8.65	0.120		7.24
	Station0006-010702-SG	G920	L22882-2	2.11	3.1	0.028	17.4	0.00285	0.00365	0.0193	0.0218	240	ND	ND				7.84	0.020		7.13
	Station0015-010702-SG	H920	L22882-3	5.49	10.9	0.06	36.3	*0.0017*	0.00237	0.00599	0.00805	130	ND	ND				8.66	0.103		7.08
	Station0016-010702-SG	F920	L22882-4	13.5	15.7	0.066	22.8	0.00301	0.00483	0.00681	0.0126	490	ND	ND				8.79	0.008		7.31
SC#1 2/21/02	Station1-022102-SC	B920	L23195-1&3	104	110	0.242	45.1	*0.002*	0.01	*0.0019*	0.0282	400	ND	ND				6.41	0.138		7.16
	Station1-022102-SC-MP	B920	L23195-2	149	174	0.307	53.2	*0.0019*	0.0143	*0.0013*	0.037							6.31	0.098		7.26
	Station0006-022102-SC	G920	L23196-1&3	16.7	6.71	0.054	8.76	*0.0017*	0.0039	0.0138	0.027	1600	ND	0.3				6.35	0.014		7.32
	Station0006-022102-SC-MP	G920	L23196-2	12	4.73	0.045	10.2	*0.0019*	0.0037	0.0174	0.0277							6.56	0.025		7.14
	Station0015-022102-SC	H920	L23194-1&3	29.4	24	0.087	33	*0.0013*	0.00294	0.00464	0.0135	290	ND	ND				6.23	0.076		6.94
	Station0015-022102-SC-MP	H920	L23194-2	24.6	25.4	0.089	33.6	0.00228	0.00289	0.00486	0.0134							6.22	0.079		6.96
	Station0016-022102-SC	F920	L23197-1&3	24.6	20.1	0.095	24.4	0.0029	0.00558	0.00501	0.0155	1000	ND	ND				6.25	0.090		7.40
	Station0016-022102-SC-MP	F920	L23197-2	5.86	3.99	0.065	26.2	0.00225	0.00307	0.00531	0.00866							6.25	0.090		7.40
SC#2 4/9/02	Station1-040902-SC	B920	L23895-1&3	7.2	2.92	0.029	68	*0.001*	*0.0016*	0.00264	0.0028	19	ND	ND				8.71	0.177		7.82
	Station1-040902-SC-MP	B920	L23895-2	5.65	2.08	0.027	70.8	*0.00092*	*0.0013*	*0.0022*	*0.0022*							8.75	0.178		7.21
	Station0006-040902-SC	G920	L23893-1&3	6.9	5.98	0.089	17.3	0.00524	0.00675	0.0359	0.0363	1800	ND	ND				10.03	0.034		7.21
	Station0006-040902-SC-MP	G920	L23893-2	11.1	5.32	0.07	12	0.0046	0.0073	0.0341	0.0411							10.03	0.034		7.21
	Station0015-040902-SC	H920	L23892-1&3	7.78	6.5	0.031	51.4	*0.0013*	*0.0019*	0.00603	0.0083	40	ND	ND				9.33	0.096		7.07
	Station0015-040902-SC-MP	H920	L23892-2	14	7.71	0.039	40.2	*0.0014*	0.00228	0.00915	0.0129							9.33	0.096		7.07
	Station0016-040902-SC	F920	L23894-1&3	4.6	2.99	0.062	31.7	0.00304	0.00413	0.00817	0.00821	190	ND	ND				9.53	0.119		7.10
	Station0016-040902-SC-MP	F920	L23894-2	9.8	3.85	0.069	34.6	0.00307	0.0043	0.0103	0.0119							9.53	0.119		7.10

ND - Non-detect (value less than MDL (Method Detection Limit))
Italics indicate value less than RDL (Reporting Detection Limit)
For storm composites, the DO and TPH values were from grab samples taken at beginning of composite sample collection and field measurements are for the first sample collected.
* Flagged conductivity seemed unusually high and problems with the conductivity meter were observed in the field. This conductivity data was qualified and presented in Table 6 but not included in the report discussion.

Laboratory quality control checks included method blanks, lab duplicates, lab control sample (spike blanks or positive controls), and matrix spikes. There were no anomalies associated with the preparation and laboratory analysis of the samples, and the data passed all internal laboratory QA/QC checks for accuracy and completeness.

Field quality control checks included field blanks, field duplicates, and field measurement quality control checks. A field blank was collected during each sampling event. All field blanks were met acceptance criteria. A field duplicate was collected at Station 1 during the October 1, 2001 storm grab sample collection and during the February 4, 2002 wet season base flow grab sample collection. The field duplicate acceptance criteria was met for all parameters for both samples except for total phosphorus, turbidity, and fecal coliforms for the February 4, 2002 the wet season base flow grab sample. The acceptance criterion as stated in the QAPP was less than 20% relative difference. Total phosphorus had a 33% relative difference and turbidity had a 46% relative difference. However, both parameters were detected at relatively low levels within three times the reporting limit for the respective parameter. Fecal coliforms had a 167% relative difference. However, the concentrations were relatively low and fecal coliforms are a highly variable parameter. The field duplicates were determined to be acceptable.

Field measurement quality control check samples were collected at Station 1 during the two baseflow sampling events to assess the accuracy of the field measurements. The quality control checks were measured in the laboratory for pH, conductivity and dissolved oxygen. The pH and dissolved oxygen field checks indicated that field equipment was accurate. The conductivity measurements on the second date indicated problems with the field equipment. This was also noticed in the field, and conductivity data collected with this instrument for this date was not included in this report. Review of the data also indicated that conductivity data collected during the first storm grab sample seemed unusually high and problems with the conductivity meter were observed in the field. This conductivity data was qualified and presented in Table 6 but not included in the discussion.

3.3 MACROINVERTEBRATE SAMPLING

A benthic macroinvertebrate sample was collected on September 12, 2001 upstream of the wetland located at the downstream end of the ravine section of the mainstem of East Hylebos Creek. As part of the macroinvertebrate sampling, habitat data for each replicate related to macroinvertebrates was collected as described in *Field Protocols for Benthic Macroinvertebrate Sampling for Use With the Benthic Index of Biotic Integrity 2000* (King County 2000). The completed Benthic Macroinvertebrate Field Data Sheet, the Physical Characterization/Water Quality Field Data Sheet, and the Habitat Assessment Field Data Sheet – High Gradient Streams, and Benthic Macroinvertebrate Sample Log-In Sheet, and the laboratory results from Ecoanalysts, Inc. are located in Appendix F.

This habitat data collected as part of the macroinvertebrate sample collection is presented in Table 7. The habitat data indicates that habitat at the locations of the replicate samples were similar.

The mean B-IBI for the ravine reach was 35 out of 50. The B-IBI for East Hylebos Creek fell within the good category (A score of 10-19 is poor, 20-29 fair, 30-39 good, and 40-50 excellent) (Fore 1999). The laboratory results of the B-IBI score from EcoAnalysts, Inc. are presented in Appendix F and summarized in Table 8.

Table 7. Habitat Data at B-IBI Collection Locations

	Date	Time	Canopy cover	Specific location[1]	Habitat Type[2]	Flow (cfs)	Water Velocity (ft/sec)	Depth (ft)	Substrate	Other
Riffle 18										
Rep1	12-Sep	1130	full shade	1440'	LGR	1.1	2.4	0.2	gravel	LWD at upstream end
Rep2	12-Sep	1135	full shade	1455'	LGR	1.1	2.2	0.4	gravel	LWD at upstream end
Rep3	12-Sep	1138	full shade	1465'	LGR	1.1	2.3	0.3	gravel	LWD at upstream end
Riffle 23										
Rep1	12-Sep	1255	partial shade	2022'	LGR	1.1	2.2	0.4	gravel	unvegetated left bank
Rep2	12-Sep	1259	partial shade	2027'	LGR	1.1	2.3	0.3	gravel	unvegetated left bank
Rep3	12-Sep	1303	partial shade	2032'	LGR	1.1	2.3	0.3	gravel	unvegetated left bank
Riffle 38										
Rep1	12-Sep	1420	partial shade	3327'	LGR	1.1	2.4	0.2	gravel	densely vegetated banks
Rep2	12-Sep	1423	partial shade	3332'	LGR	1.1	2.3	0.3	gravel	densely vegetated banks
Rep3	12-Sep	1429	partial shade	3337'	LGR	1.1	2.4	0.2	gravel	densely vegetated banks

[1] Linear distance upstream from start of habitat survey.
[2] LGR = low gradient riffle.

3.4 STREAM HABITAT SURVEY

The stream habitat survey was conducted on August 27 and 29, 2001. Approximately 3500 feet (River Mile 5.8 – 6.4) of the ravine reach of the main branch of East Hylebos Creek were surveyed following the methods outlined in *Inventory Methods for Wadable Streams in King*

County (King County 2001). The completed Habitat Unit Survey Forms, LWD Level 1 Data Forms, and Wolman Pebble Count Data Forms are included in Appendix G. Appendix H contains ten photos from the habitat survey.

Table 8. Puget Sound Lowland B-IBI Results for East Hylebos Ravine

	Riffle 18		Riffle 23		Riffle 38	
Taxa Richness and Composition	**Value**	**Score**	**Value**	**Score**	**Value**	**Score**
Species richness	48.00	5	43.00	5	45.00	5
Ephemeroptera richness	7.00	3	5.00	3	5.00	3
Plecoptera richness	7.00	3	8.00	5	7.00	3
Trichoptera richness	8.00	3	6.00	3	6.00	3
Long-Lived taxa richness	2.00	1	3.00	3	3.00	3
Tolerance						
Intolerant taxa richness	16.00	5	15.00	5	15.00	5
% Tolerant taxa	0.38	3	0.29	3	0.69	1
Feeding Ecology						
% Predators	20.79	5	13.12	3	11.23	3
Clinger richness	18.00	3	19.00	3	16.00	3
Population Attributes						
% 3 dominant taxa	59.55	3	46.32	5	37.92	5
BIBI Score		**34**		**38**		**34**
BIBI Mean Score		**35**				

On August 27th the ravine reach was accessed by walking upstream from Station 1 (RM 5.3). The creek upstream of Station 1 is a low gradient depositional reach with sand substrate, scarce LWD, and a canary reed grass dominated riparian buffer. The floodplain is approximately 100 meters wide until a wetland is reached at approximately RM 5.6. This wetland contained a dense under and over story of native shrubs. At the upstream end of the wetland the floodplain narrows and the ravine reach begins.

The habitat types observed in the surveyed portion of East Hylebos Creek are summarized in the Table 9. This table presents the sequential order of 93 habitat units surveyed, starting just upstream of the wetland (RM 5.8) and proceeding to 3338 feet upstream (RM 6.4). This table lists the type of habitat, average width, average wetted depth, maximum depth, total length, pool quality index, and relevant comments about each distinct habitat unit. Habitat ID as shown on the Habitat Unit Survey Forms field data sheets (Appendix G) are used in the Summary Table of Habitat Data to indicate the sequential order of habitats observed.

Table 9. Habitat Data Summary (refer to Figure 3 for Habitat Type abbreviations)

Habitat ID	Habitat Type	Total Length (ft)	Mean Wetted Width (ft)	Area (LxW)	Mean Depth (riffles)	Max Depth (pools)	Pool Quality Index	Comments
P1	LSP	22	9	205	-	1.95	3	condos 75' from right bank
R2	LGR	43	5	229	0.35	-	-	photo 5
P2	LSP	27	9	234	-	1.1	2	roots from cottonwood from LB
R2	LGR	123	6	779	0.28	-	-	edgewater pool LB, condos 50' from right bank
P3	DP	24	6	152	-	0.9	2	formed by LWD
P4	LSP	16	14	224	-	1.4	1	root on RB forms pool
R3	LGR	46	10	475	0.23	-	-	
P5	LSP	20	9	170	-	1.5	3	
P6	LSP	35	5	163	-	1.6	3	
R4	LGR	29	10	290	0.13	-	-	wetted/side channel RB
G1	GLD	47	10	470	0.55	-	-	
P7	MCP	8	12	93	-	1.1	2	LWD scouring pool
R5	LGR	33	10	330	0.23	-	-	wetland on LB
P8	MCP	30	12	350	-	1	2	
DC1	DC	55	14	770	0.28	-	-	
G2	GLD	33	11	352	0.50	-	-	
R6	LGR	29	12	338	0.15	-	-	
G3	GLD	38	9	342	0.30	-	-	
P9	LSP	18	11	192	-	1.5	4	
R7	LGR	82	6	506	0.18	-	-	LWD jam mid-riffle
P10	LSP	17	6	96	-	0.9	2	
R8	LGR	42	8	315	0.33	-	-	trib on RB
P11	LSP	15	6	88	-	1.2	3	log formed
R9	LGR	15	6	90	0.15	-	-	
G4	GLD	45	7	300	0.33	-	-	
P12	PLP	9	18	162	-	1.6	4	
G5	GLD	24	5	128	0.58	-	-	
R10	LGR	90	5	450	0.18	-	-	
P13	LSP	18	10	174	-	1.4	3	pebble count at tail out
R11	LGR	17	4	65	0.10	-	-	
P14	LSP	19	8	143	-	1.5	4	nurse stump forms LB
R12	LGR	20	7	130	0.10	-	-	
P15	BWP	21	7	144	-	1.5	3	root formed
R13	LGR	14	8	117	0.23	-	-	small side channel 3' wide separated by 4' berm
G6	GLD	26	10	247	0.40	-	-	side channel splits off
R14	LGR	44	11	462	0.20	-	-	backwater pool on LB, side channel at high flows
G7	GLD	66	6	385	0.50	-	-	Long pool on LB, split by gravel bar
R15	LGR	39	8	299	0.18	-	-	
P16	LSP	16	25	395	-	1.5	4	
R16	LGR	14	10	140	0.08	-	-	
P17	LSP	26	10	264	-	2.9	4	
R17	LGR	40	13	507	0.13	-	-	

Table 9. Habitat Data Summary (continued)

Habitat ID	Habitat Type	Total Length (ft)	Mean Wetted Width (ft)	Area (LxW)	Mean Depth (riffles)	Max Depth (pools)	Pool Quality Index	Comments
P18	LSP	40	16	653	-	1.6	4	
R18	LGR	35	5	175	0.25	-	-	
DC2	DC	13	9	121	0.50	-	-	
P19	PLP	7	17	121	-	1	3	
R19	LGR	112	17	1867	0.18	-	-	RB pool separated by gravel bar
P20	MCP	23	12	272	-	1.7	4	
R20	LGR	163	7	1060	0.15	-	-	pools on RB, long riffle-many DCs
P21	MCP	22	10	220	-	1.8	4	
P22	LSP	20	10	197	-	2.4	4	rootwad pool formed
R21	LGR	100	8	750	0.10	-	-	
DC3	DC	32	15	480	0.13	-	-	W2 spans a gravel bar
G8	GLD	19	8	152	0.30	-	-	
R22	LGR	7	6	43	0.10	-	-	
P23	LSP	10	8	83	-	1.3	3	logged formed
DC4	DC	19	9	174	0.24	-	-	
R23	LGR	8	4	30	0.16	-	-	
P24	BWP	9	12	107	-	1.2	2	logged formed
R24	LGR	18	11	204	0.10	-	-	
P25	MCP	12	11	128	-	1.8	3	logged formed
R25	LGR	35	6	198	0.23	-	-	
P26	LSP	19	11	215	-	1.3	2	root formed
R26	LGR	81	7	594	0.11	-	-	side channel
SC1	SC	49	2	114	0.04	-	-	sub habitat unit
P27	MCP	14	10	138	-	1	2	log formed
R27	LGR	34	15	499	0.13	-	-	no floodplain to R30
P28	MCP	16	15	232	-	1.2	2	habitat units are getting smaller, log formed
R28	LGR	96	13	1280	0.15	-	-	
P29	LSP	23	20	449	-	2	4	rootwad pool formed, 5 foot riffle separates P29 and P30
P30	LSP	28	9	254	-	1.1	3	rootwad formed
R29	LGR	147	8	1201	0.13	-	-	
P31	BWP	49	18	858	-	1.8	4	log formed
R30	LGR	19	11	200	0.08	-	-	
P32	LSP	32	7	229	-	1.2	3	cutbank roots on LB
R31	LGR	13	10	126	0.15	-	-	
P33	BWP	129	14	1866	-	1.5	4	log formed
R32	LGR	6	13	76	0.11	-	-	
P34	LSP	30	6	175	-	1.2	-	log formed
R33	LGR	73	8	584	0.11	-	-	
P35	LSP	36	8	282	-	0.8	2	log formed
R34	LGR	54	7	403	0.10	-	-	
P36	PLP	11	11	121	-	1.3	3	log formed
R35	LGR	31	11	336	0.10	-	-	

Table 9. Habitat Data Summary (continued)

Habitat ID	Habitat Type	Total Length (ft)	Mean Wetted Width (ft)	Area (LxW)	Mean Depth (riffles)	Max Depth (pools)	Pool Quality Index	Comments
PL7	BWP	30	11	330	-	1.1	3	
DC5	DC	53	21	1122	0.20	-	-	DC is causing braids ds
P38	LSP	32	8	249	-	1.4	3	log formed
R36	LGR	16	9	144	0.21	-	-	
P39	LSP	74	9	666	-	2	3	rootwad formed
P40	BWP	17	8	130	-	1.2	2	P29 and 30 separated by short riffle
R37	LGR	44	12	528	0.10	-	-	
P41	BWP	16	10	160	-	1.2	3	wood formed
R38	LGR	16	6	96	0.16	-	-	

The following features of East Hylebos Creek within the surveyed reach can be deduced based on the dimensions of the channel measured in these 93 distinct habitat units. The stream habitat type with the greatest area (length times average wetted width) was low gradient riffle (LGR; 50%) (Figure 3). All pool habitat types combined accounted for 35% of the surveyed habitat area. The mean width of the wetted channel was 10 feet and the mean bankfull width was 30 feet. The mean maximum depth of all pools was 1.4 feet. There were 40 pools in the surveyed reach for a pool frequency of 63 per mile. There were no large pools (i.e., greater than one meter in depth). The modal ranking for pool quality in the survey area was a three out of five possible (Platts et al. 1987). There were no high quality pools (i.e., scores of five) observed.

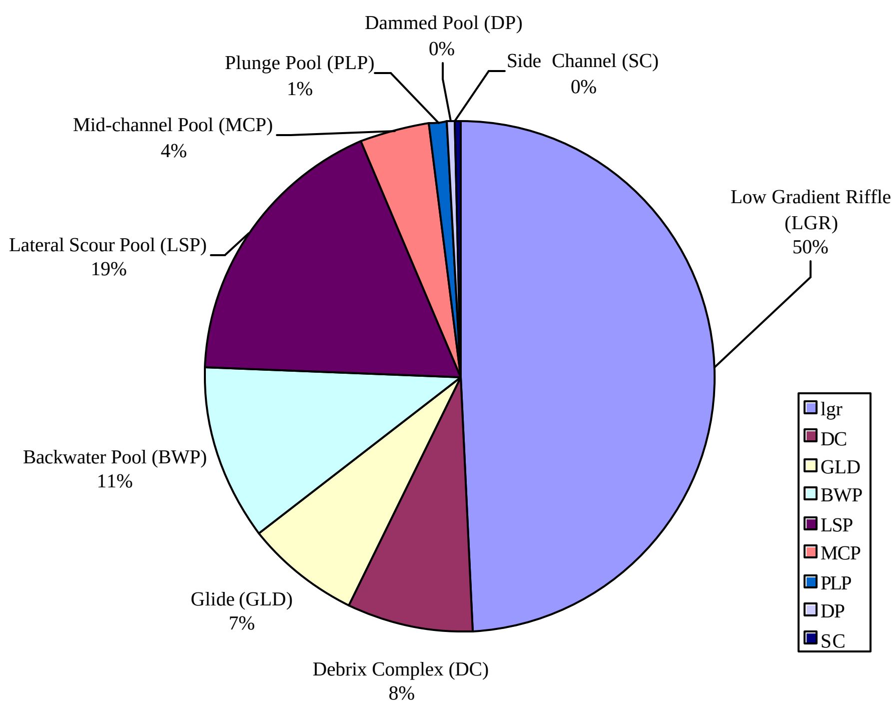


Figure 3. East Hylebos Ravine Habitat Units

Wolman pebble counts were taken at two randomly selected pools representative pool tail-outs (Pool 13 and Pool 31). Results are summarized in Table 10, and detailed results are found on the completed Wolman Pebble Count Data Forms in Appendix G. Results for the two stations were similar.

Table 10. Wolman Pebble Count Summary

	Pool 13	Pool 31
% fines (<6mm)	24%	22%
D10	<2 mm (very fine fines)	<2 mm (very fine fines)
D50	12 - 16 mm (medium gravels)	16 - 24 mm (medium gravels)
D84	24 - 32 mm (coarse gravels)	32 - 48mm (very coarse gravels)

Diameter ranges and particle categories are those described in *Inventory Methods for Wadable Streams in King County* (King County 2001)

There were 159 pieces of LWD in the survey reach for an estimate of 259 pieces per mile. Thirty-eight (24%) of the LWD pieces were large (diameter greater than 50 cm). Forty-four (28%) of the LWD pieces were medium (diameter between 30 to 50 cm). Seventy-seven (48%) of the LWD pieces were small (diameter between 10 to 30 cm). For details of the LWD results, refer to completed LWD Level 1 Data Forms (Appendix G).

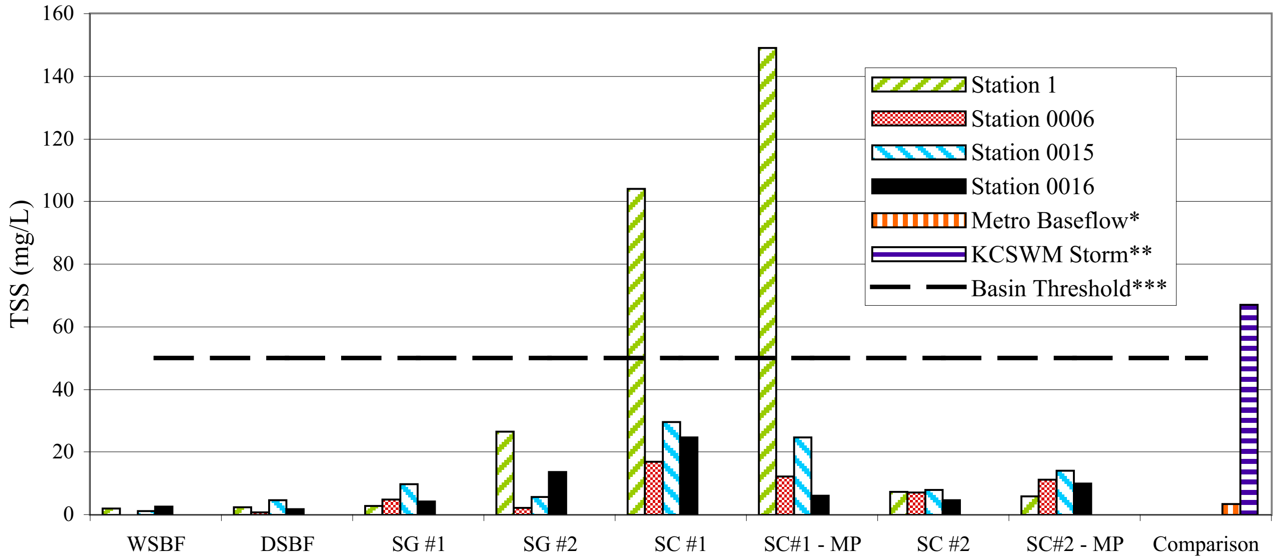
The native riparian trees on both banks were dominated by medium sized (12-20 inch diameter), hardwoods (>70% of the trees are hardwood). Although not quantified as part of the survey, it is estimated that approximately 20% of the trees were mature conifers. The riparian buffer was wide and dense (more than 1/3 of the riparian condition unit (RCU) is covered by trees) extending up both banks of the ravine.

4.0 DISCUSSION

4.1 WATER QUALITY

This section discusses the water quality data by parameter. Total suspended solids, turbidity, total phosphorus, total copper, dissolved copper, total zinc, dissolved zinc, fecal coliforms, and conductivity results are summarized in Figures 4 through 12, respectively. Where applicable, results are compared to Ecology water quality standards for Class A surface waters (WAC 173-201A-030 and WAC 173-201A-040). Where applicable, results are also compared to baseflow and stormflow water quality grab samples results summarized in the *Current and Future Conditions Report* (King County 1990a) and to data collected by the Hylebos Creek Stream Team in 2001.

Two sources of water quality data from the *Current and Future Conditions Report* will be used for comparison purposes. For both these sources, only summarized data (i.e., not raw data) is presented in the *Current and Future Conditions Report*. The summary statistic (e.g., median, geometric mean, maximum, minimum) presented for each parameter in the *Current and Future Conditions Report*, is the value used for comparison purposes in this report.



*METRO Baseflow is the median value of baseflow grab samples collected by METRO at Station 1.
**KCSWM Storm is the median value of storm grab samples collected by KSCWM in the East Hylebos basin.

Figure 4. Total Suspended Solids

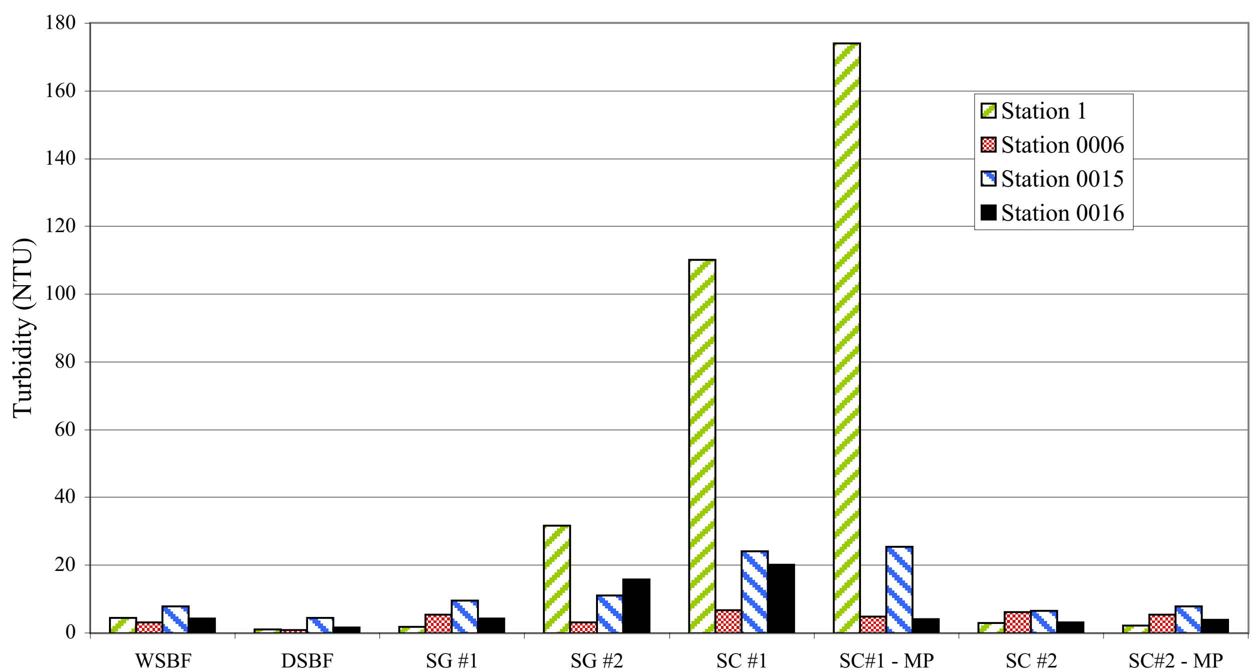
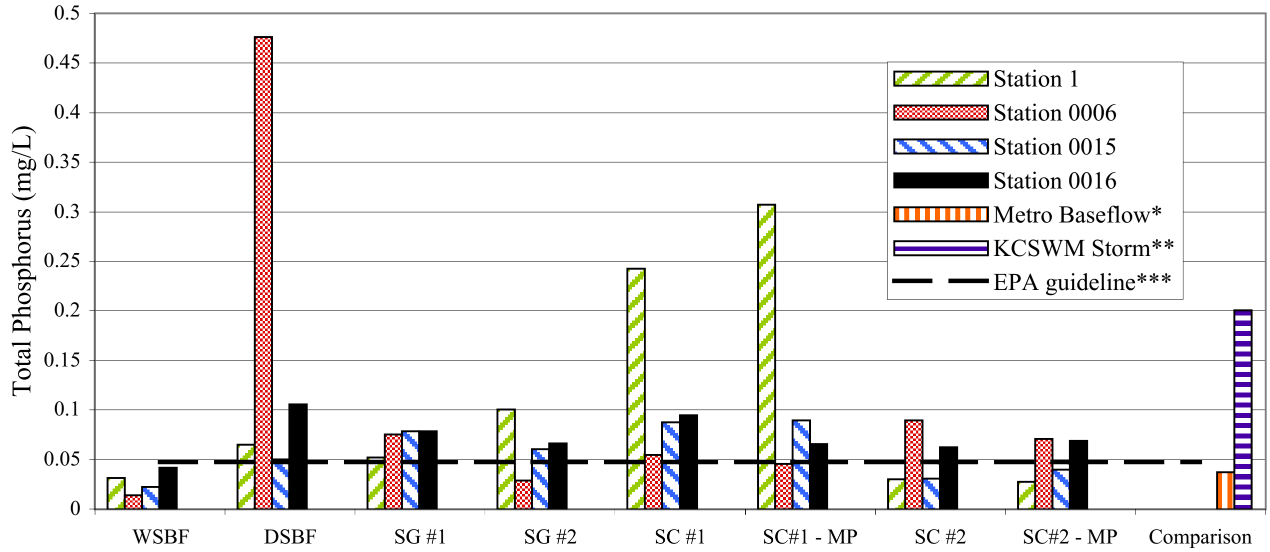
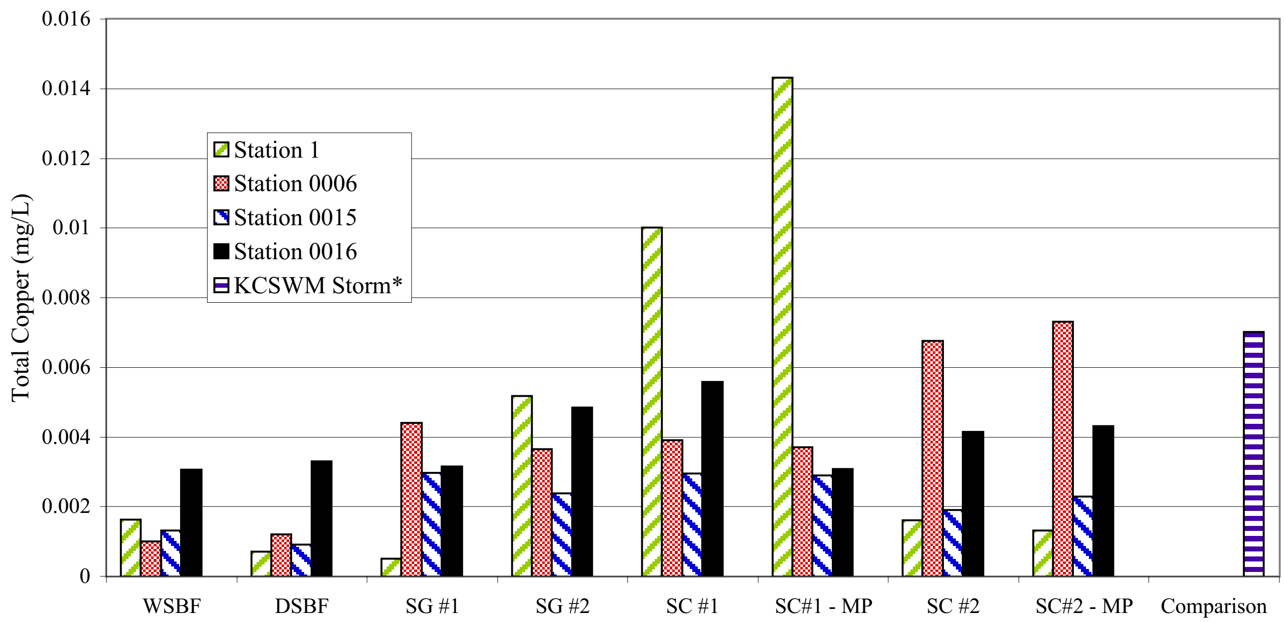


Figure 5. Turbidity



*METRO Baseflow is the median value of baseflow grab samples collected by METRO at Station 1.
**KCSWM Storm is the median value of storm grab samples collected by KSCWM in the East Hylebos basin.
***EPA guideline is the recommended criteria for nutrient ecoregion I (0.047 mg/L).

Figure 6. Total Phosphorus



*KCSWM Storm is the median value of storm grab samples collected by KSCWM in the East Hylebos basin.

Figure 7. Total Copper

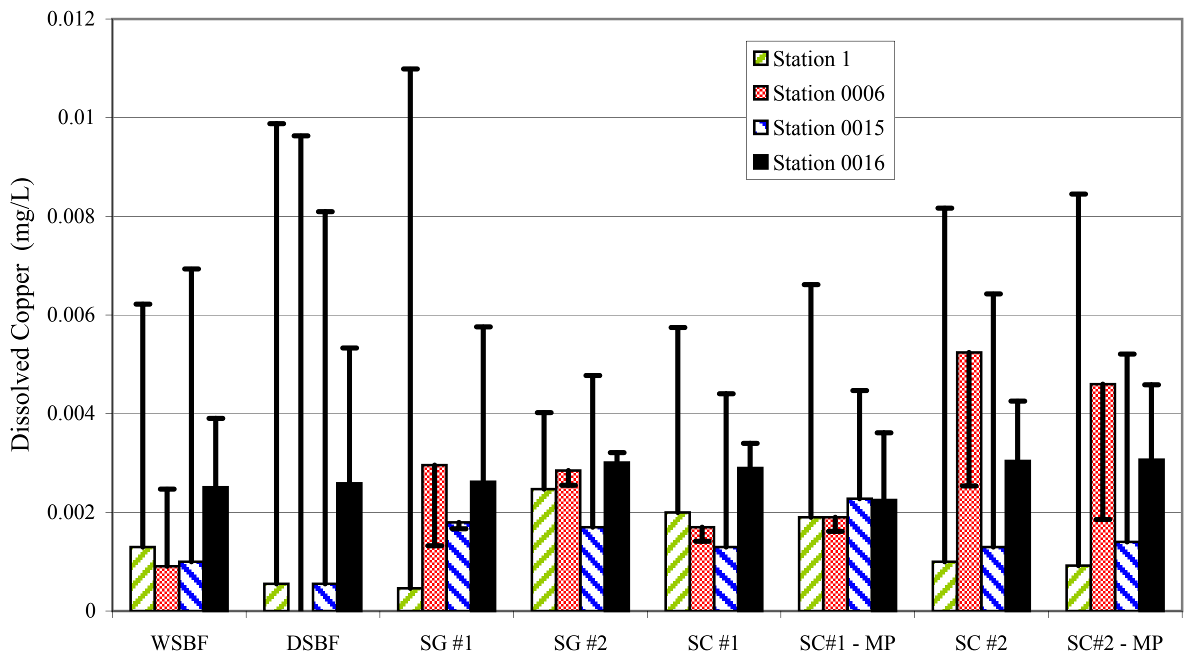
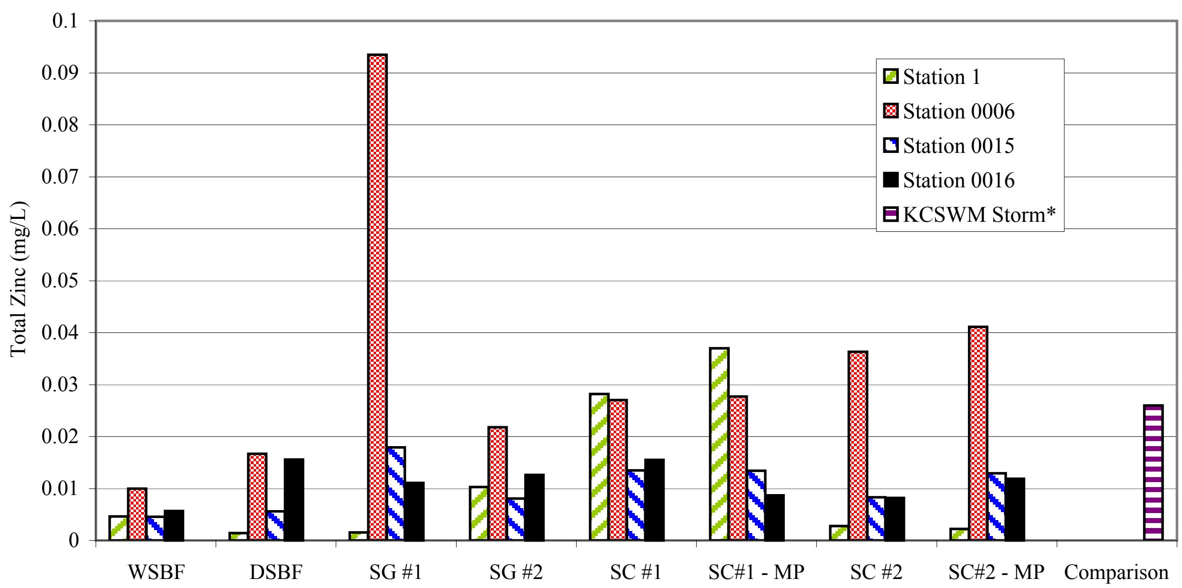


Figure 8. Dissolved Copper (vertical bars indicate Ecology's chronic dissolved copper criteria for each sample based on sample hardness)



*KCSWM Storm is the median value of storm grab samples collected by KSCWM in the East Hylebos basin

Figure 9. Total Zinc

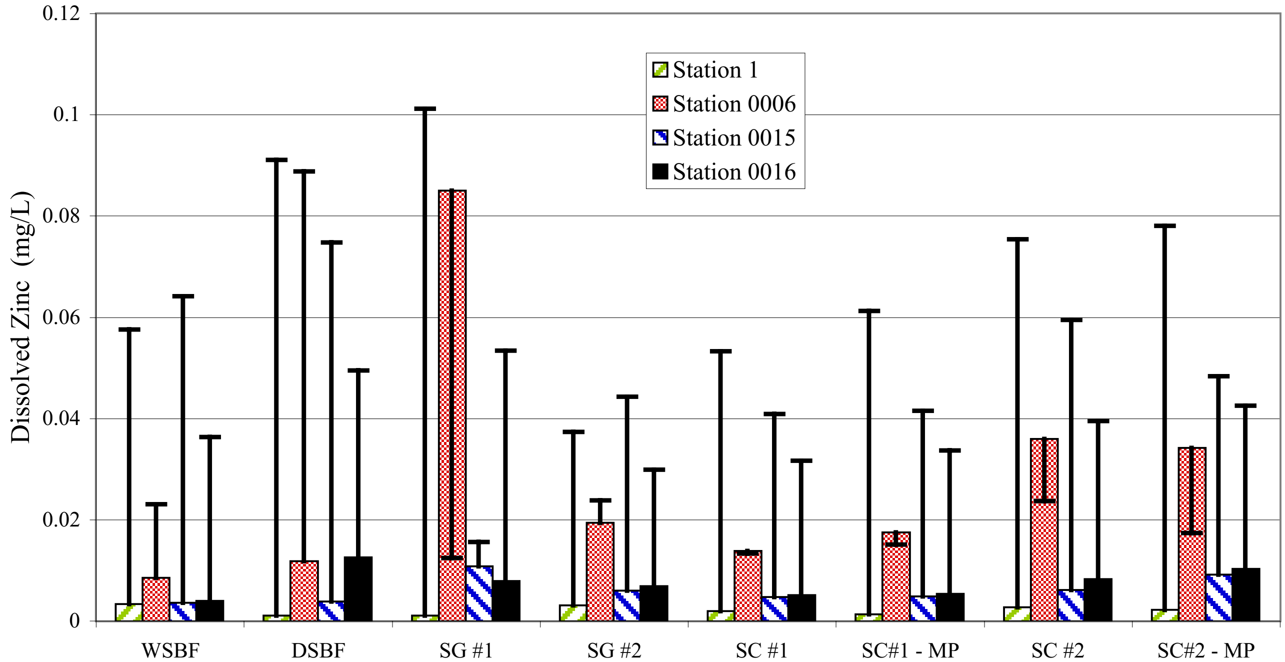
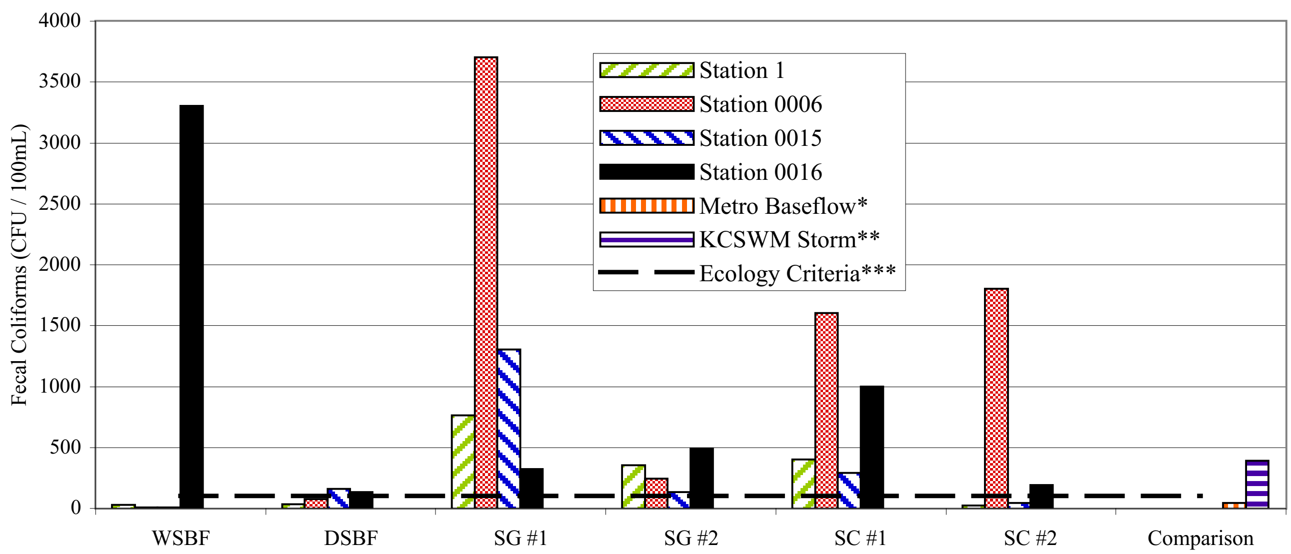


Figure 10. Dissolved Zinc (vertical bars indicate Ecology's chronic dissolved copper criteria for each sample based on sample hardness)



*METRO Baseflow is the geometric mean of baseflow grab samples collected by METRO at Station 1 (42 CPU/100 mL).
**KCSWM Storm is the geometric mean of stor grab samples collected at Station 1 (386 CPU/100 mL).
***Ecology's criterion ofr fecal coliform bacteria is < 100 colonies / 100 mL.

Figure 11. Fecal Coliforms

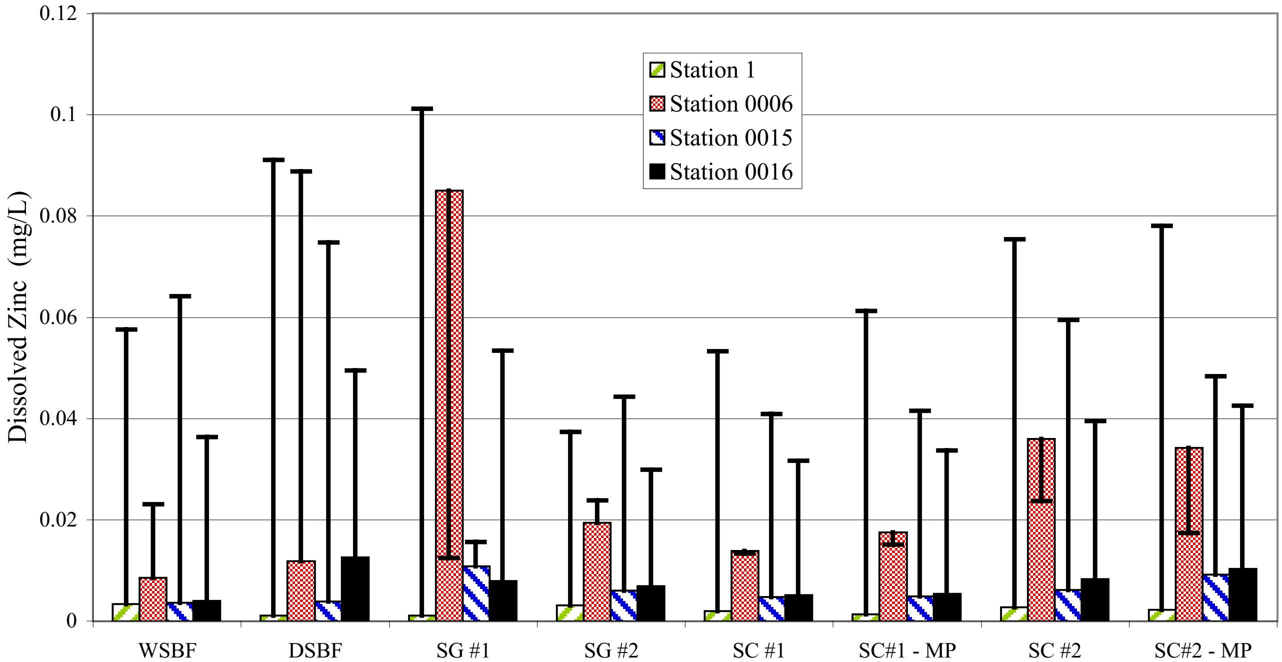
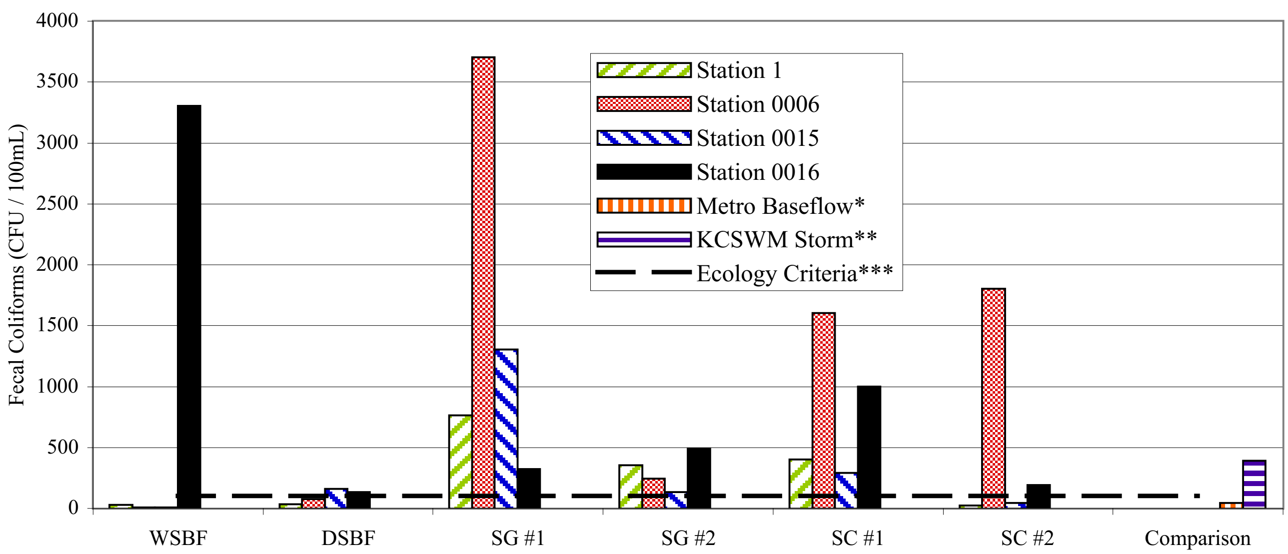


Figure 10. Dissolved Zinc (vertical bars indicate Ecology's chronic dissolved copper criteria for each sample based on sample hardness)



*METRO Baseflow is the geometric mean of baseflow grab samples collected by METRO at Station 1 (42 CPU/100 mL).
**KCSWM Storm is the geometric mean of stor grab samples collected at Station 1 (386 CPU/100 mL).
***Ecology's criterion ofr fecal coliform bacteria is < 100 colonies / 100 mL.

Figure 11. Fecal Coliforms

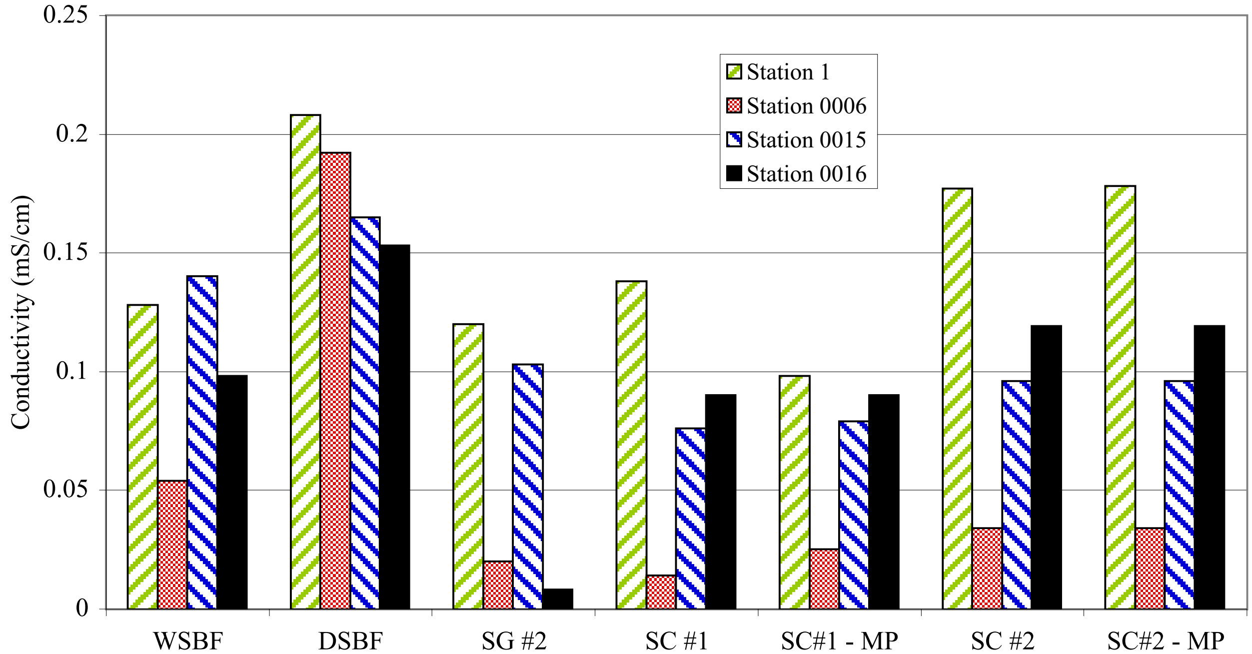


Figure 12. Conductivity. No data for SG#1.

The first source is baseflow grab samples collected by Metro at seven locations in the Hylebos Creek and Lower Puget Sound Basin monthly from May 1987 through April 1988. This data will be referred to as METRO baseflow data for the purposes of the report. One of the seven stations was located on East Hylebos Creek (QEH1) and is the same as Station 1 from this study. The mean of the baseflow samples collected at Station 1 during the Metro study period for fecal coliform bacteria, total phosphorus, and total suspended solids is presented in the *Current and Future Conditions Report* and will be used for comparison purposes. The minimum, median, and maximum values for all samples collected at the seven METRO stations for dissolved oxygen, turbidity, TSS, and total phosphorus are also presented in the *Current and Future Conditions Report* and will be discussed in relation to the data collected as part of this study, as relevant. Water quality samples from the METRO baseflow study appear to have been collected in a similar manner as the baseflow samples for this study, and it is assumed similar methods were used for analysis of most parameters. Due to improvements in laboratory methods over time, metals analysis results from this study most likely had lower detection limits than those from the METRO baseflow study. This would be a concern if the median values reported in the *Current and Future Conditions Report* for the METRO baseflow study were derived from a significant numbers of non-detects, depending on how non-detects were valued when calculating median values. Further research into the methods and data analysis methods of the METRO study data would be needed to resolve this issue. For the purposes of this report, the assumption was made that the median values were not derived from a significant number of non-detect results. In general, the METRO data appears to be directly comparable to data collected in this study.

The second source of water quality data summarized in the *Current and Future Conditions Report* is grab samples collected during storm events by King County Surface Water Management (KCSWM) during three storms in 1989 and 1990 at up to 32 locations. This data will be referred to as KCSWM storm data for the purposes of this report. Grab samples were obtained early or near the peak of storms. Four of these locations were on East Hylebos Creek on Branch 0016 and one was the current Station 1 location. The geometric mean of storm event samples collected at Station 1 (QEH1) for fecal coliform bacteria, total phosphorus, and TSS as part of the KCSWM storm study are presented in the *Current and Future Conditions Report* and will be used for comparison purposes. The mean values for all storm samples collected in the East Hylebos basin for fecal coliforms, total phosphorus, TSS, copper, and zinc are also presented in the *Current and Future Conditions Report* and will be discussed in relation to the data collected as part of this study, as relevant. Water quality samples from the KCSWM storm study appear to have been collected in a similar manner as the storm event grab samples for this study. It is assumed similar methods were used for analysis of most parameters, and the results are directly comparable. Due to improvements in laboratory methods over time, metals analysis results from this study most likely had lower detection limits than those from the KCSWM study. This would be a concern if the median values reported in the *Current and Future Conditions Report* for the KCSWM storm study were derived from a significant numbers of non-detects, depending on how non-detects were valued when calculating mean values. Further research into the methods and data analysis methods of the KCSWM study data would be needed to resolve this issue. For the purposes of this report, the assumption was made that the median values were not derived from a significant number of non-detect results. In general, the KCSWM storm data appears to be directly comparable to data collected in this study. The storm composite sample data collected as part of this study (i.e., 2001 East Hylebos Creek Monitoring Program) is representative of water quality conditions over a longer time period but can still be compared to the KCSWM storm data.

Water quality data collected by the Hylebos Creek Stream Team consisted of semi-routine monthly grab samples at seven locations in the North and West Forks of Hylebos Creek and one station on the East Fork (same as Station 1 in this study) during 1999, 2000, and 2001. Only data from 2001 is discussed in this report. This data will be referred to as Stream Team data for the purposes of this report. Samples were not collected at each station every month, and it is not stated whether samples were collected during baseflow or storm events. All parameters (except for turbidity and conductivity) were measured in the field by volunteers using Hach water quality monitoring kits (Hylebos Creek Stream Team, 2000). Thus, the results from the Stream Team data monitoring program are not directly comparable to results from this study. However, the Stream Team data does allow for rough comparisons and will be discussed in general terms for appropriate parameters. The City of Federal Way did not collect any water quality samples during 2001 that can be used for comparison purposes for this report.

4.1.1 Total Suspended Solids (TSS)

TSS results from this study along with comparison data from the METRO and KCSWM studies are presented in Figure 4. Results greater than the method detection limit (MDL) (0.5 mg/L) but less than the laboratory reporting detection limit (RDL) (1 mg/L) are included in the figure. The basin plan threshold value of 50 mg/L was set by King County in the *Current and Future Conditions Report* for data evaluation purposes and is shown on Figure 4. TSS concentrations were low at all stations during baseflow events and values were similar to the median value from the METRO baseflow study. TSS concentrations were elevated during storm events at all stations but were below the basin plan threshold value except for at Station 1 during the first storm composite sample event. The storm composite sample (SC #1) TSS concentration was 104 mg/L, and the most polluted sample of the six grab samples collected (SC#1-MP) had a TSS concentration of 149 mg/L. Both these values are higher than the maximum storm grab TSS concentration observed at Station 1 as part of the KSCWM storm event study (83 mg/L). The median value of the storm grab samples from the KSCSWM study (67 mg/L) falls between the high and low storm grabs observed as part of this study.

In summary, TSS is not a concern during baseflow conditions, but TSS levels are elevated during storm events, especially at Station 1. At this station, two samples exceeded the recommended basin threshold set in the King County *Current and Future Conditions Report*. The TSS results from this study do not appear to be substantially different from previous studies.

4.1.2 Turbidity

Turbidity results from this study are presented in Figure 5. Results greater than the MDL (0.5 NTU) but less than the RDL (2 NTU) are included in the figure. The turbidity results are similar to those observed for TSS. Ecology's standard for turbidity is based on background conditions (e.g., turbidity shall not exceed 5 NTU over background turbidity when background turbidity is 50 NTU or less) (WAC 173-201A-030). Since background turbidity levels were not defined and established for this study, this standard is not applicable to this study. Turbidity levels were relatively low during baseflow conditions and are similar to the values from the Hylebos/Lower Puget Sound stations during the METRO baseflow study (the METRO value is not shown on the graph because it is not specific to the East Hylebos Basin since it is an average of samples collected within the Hylebos and Lower Puget Sound basins). Turbidity levels were elevated during storm events, especially at Station 1. Turbidity data was not available for the KCSWM study. Except for the Station 1 storm events, turbidity data was within the range of values (0.47 – 18 NTU) observed by the Hylebos Creek Stream Team during monthly visits. As the Hylebos Creek Stream Team did not document whether data was collected during storm events, it is not possible to directly compare results.

In summary, turbidity is not a concern during baseflow conditions, but turbidity levels are elevated during storm events, especially at Station 1.

4.1.3 Total Phosphorus

Total phosphorus results from this study along with comparison data from the METRO and KCSWM studies are presented in Figure 6. The recommended EPA criteria for total phosphorus in rivers and streams for aggregate nutrient ecoregion I is 0.047 mg/L (EPA, 2001) and is shown on Figure 6. TP concentrations were below the EPA criteria at all stations during the wet season baseflow event and similar to the median value from the METRO baseflow study. During the dry season baseflow event, the EPA criterion was exceeded at all stations and concentrations were greater than the median value from the METRO baseflow study, most significantly at Station 0006 (0.476 mg/L). This value is substantially greater than the maximum value observed in the METRO baseflow study for the seven stations (0.14 mg/L). The total phosphorus concentrations during storm events exceeded the EPA criteria at most stations during most storm events. Total phosphorus levels were particularly elevated at Station 1 during the first storm composite sampling event. The median value of the storm grab samples collected from the East Hylebos basin as part of the KCSWM storm study (0.20 mg/L) falls between the high and low storm grabs observed as part of this study. Except for data from the dry season baseflow grab event and Station 1 storm events, total phosphorus data are within the range of values (0.01 – 0.18 mg/L) observed by the Hylebos Creek Stream Team during monthly visits. As it is not known if the Hylebos Creek Stream Team data was collected during storm events, it is not possible to directly compare results.

In summary, total phosphorus is a concern in East Hylebos Creek. The recommended EPA criterion was exceeded at all stations particularly during dry season baseflow and storm events. The highest concentrations were observed at Station 0006 during baseflow sampling and at

Station 1 during storm event sampling. Elevated phosphorus conditions can promote productivity (which in turn can lower dissolved oxygen levels in a stream) and can be and indicator of pollutant input to the basin although natural sources (e.g., soil, birds, plant die back) can also contribute to elevated levels. Based on data collected, total phosphorus could not be differentiated from results from previous studies.

4.1.4 Copper – Total and Dissolved

Total copper results from this study along with comparison data from the KCSWM study are presented in Figure 7. Results greater than the MDL (0.0004 mg/L) but less than the RDL (0.002 mg/L) are included in the figure. Except for at Station 0016, baseflow samples were below the RDL. This result is similar to the results of the METRO baseflow study in which metal levels were quite low and often undetected. However, as discussed earlier, metals laboratory analysis method used for the METRO baseflow study likely had a higher detection limit. Thus, non-detects between these two studies are not directly comparable. During most storm events sampled as part of this study, total copper concentrations were elevated. Station 1 and Station 0006 exhibited the highest total copper concentrations during storm events. Most of the storm grab samples had lower concentrations than the median value of the storm grab samples from the East Hylebos basin from the KSCSWM study (0.007 mg/L). However, the number of non-detects and how they were valued in the KCSWM study were not investigated as part of this study. This may make the direct comparison of the data inappropriate. Total copper data from monthly grab samples collected by the Hylebos Creek Stream ranged from 0.002 to 0.004 mg/L. These values are similar to what was observed during baseflow samples. As it is not known if the Hylebos Creek Stream Team data was collected during storm events, it is not possible to directly compare results.

Dissolved copper results from this study are presented in Figure 8. Results greater than the MDL (0.0004 mg/L) but less than RDL (0.002 mg/L) are included in the figure. Dissolved copper results from this study are discussed in relation to Ecology's chronic and acute criteria for dissolved copper (WAC 173-201A-040). As defined by Ecology, chronic conditions are changes in the environment (e.g., chemical) which are expected or demonstrated to result in injury or death to an organism as a result of repeated or constant exposure over an extended period of time to a substance. Acute conditions are changes in the environment which are expected or demonstrated to result in injury or death to an organism as a result of short-term exposure to the substance or condition. The project sampling design was not intended to correspond to Ecology's time duration criteria for either chronic or acute criteria (4-day average and 1-hour average, respectively). Chronic criteria for each sample are shown as a vertical bar in Figure 8 since they are a more conservative value (i.e., lower concentration) than the acute criteria, and, as such, serve as a better indicator of potential areas of concern. However, the acute criteria time duration is more closely related to the time durations of the grab and composite samples collected as part of this study since they are intended to provide a short-term maximum concentration. Chronic and acute criteria are calculated as a function of the hardness of each sample. These calculations and relationships to Ecology acute and chronic criteria are presented in a table in Appendix J. Baseflow samples were below the chronic criteria at all stations. The chronic criterion was exceeded at Station 0015 on the first storm grab sample (SG#1). Station 0006 exceeded the chronic criteria for all storm event samples. This was, in part, due to low water hardness associated with these samples. The acute criteria were also exceeded at Station 0006 for SG #1 (sample concentration = 0.00296 mg/L, acute criteria = 0.0016 mg/L), SC #2 (sample concentration = 0.00524 mg/L, acute criteria = 0.0033 mg/L), and SC#2 – MP (sample concentration = 0.0046 mg/L, acute criteria = 0.0023 mg/L). Since the collection duration periods are similar between grab and composite samples from this study and Ecology's criteria, concentrations greater than the acute criteria likely represents an exceedance of Ecology's criteria.

In summary, copper toxicity is a concern during storm events, especially at Station 0006. Copper toxicity was not a concern during baseflow periods. Total copper values are similar to those found in other studies cited in this report.

4.1.5. Zinc – Total and Dissolved

Total zinc results from this study along with comparison data from the KCSWM storm study are presented in Figure 9. Results greater than the MDL (0.0005 mg/L) but less than the RDL (0.0025 mg/L) are included in the figure. In general, baseflow samples had low zinc levels and were similar to the results of the METRO baseflow study in which metal levels were generally low. The highest total zinc concentrations were observed at Station 1 and Station 0006 during storm events. The median value of the storm grab samples from the KCSWM study (0.026 mg/L) reported in the *Current and Future Conditions Report* falls between the high and low values for storm grabs observed as part of this study.

Dissolved zinc results from this study are presented in Figure 10. Results greater than the MDL (0.0005 mg/L) but less than RDL (0.0025 mg/L) are included in the figure. Dissolved zinc results from this study are discussed in relation to Ecology's chronic and acute dissolved zinc criteria (WAC 173-201A-040). The project sampling design was not intended to correspond to the time duration criteria for either chronic or acute criteria (4-day average and 1-hour average, respectively). Chronic criteria for each sample are shown as a vertical bar in Figure 10 since they are a more conservative value (i.e., lower concentration) than the acute criteria, and, as such, serve as a better indicator of potential areas of concern. However, the acute criteria time duration is more closely related to the time durations of the grab and composite samples collected as part of this study since they are intended to provide a short-term maximum concentration. Chronic and acute criteria are calculated as a function of the hardness of each sample. These calculations are shown in Appendix J. Baseflow samples were below the chronic criteria at all stations. Station 0006 exceeded the chronic criteria for zinc for all storm event samples except the second storm grab event (SG#2). This results from a combination of low water hardness and high dissolved zinc concentrations. The acute criteria was also exceeded at Station 0006 for SG#1 (sample concentration = 0.085 mg/L, acute criteria = 0.0136 mg/L), SC#1- MP (sample concentration = 0.0174 mg/L, acute criteria = 0.0165 mg/L), SC#2 (sample concentration = 0.0359 mg/L, acute criteria = 0.0259 mg/L), and SC#2 – MP (sample concentration = 0.0341 mg/L, acute criteria = 0.0190 mg/L). The collection method for the storm composite sample is similar in duration to the acute criteria. Thus, the exceedance of the acute criteria in a storm composite sample likely represents an exceedance of Ecology's criteria.

In summary, zinc toxicity is a concern at Station 0006 during storm events. Ecology's acute or chronic criteria were not exceeded at other stations. Total zinc concentrations for storm events are similar to the data collected as part of the KCSWM study.

4.1.6 Fecal Coliform Bacteria

Fecal coliform results from this study along with comparison data from the METRO and KCSWM studies are presented in Figure 11. Ecology's fecal coliform criterion for Class A surface waters is 100 colonies / 100 mL (WAC 173-201A-030) and is shown in Figure 11. Most of the samples collected exceeded Ecology's criteria. However, the wet season baseflow samples were below the Ecology criterion except at Station 0016. The dry season baseflow samples were below or near Ecology's criteria. The dry season baseflow samples and the Station 0016 wet season baseflow sample had greater fecal coliform levels than the METRO baseflow study. Storm event samples showed elevated fecal coliform levels, and all storm event samples exceeded Ecology's criterion with the exception of Station 1 and Station 0015 during the second storm composite sample collection (SG#2). The majority of the storm grab samples from this study are higher than samples collected at Station 1 as part of the KCSWM study and higher than the geometric mean of all fecal coliform samples (372 colonies/100 mL) collected in the East Hylebos basin as part of the KCSWM study. However, the Station 1 data from storm events is similar to what was observed during the KCSWM study at Station 1.

In summary, high fecal coliform levels continue to be a concern in the East Hylebos basin as they are in the Hylebos watershed. Both Hylebos Creek and the West Fork of Hylebos Creek are listed on Ecology's 303d list of threatened and impaired water bodies due to fecal coliform levels. Ecology's fecal coliform criterion was exceeded in almost all samples collected as part of this study. Fecal coliform samples are typically highly variable; however, based on comparison with previously collected data, it appears fecal coliform levels may be increasing in the basin.

4.1.7 Total Petroleum Hydrocarbons (TPH)

Total petroleum hydrocarbons in the diesel range were not detected in any of the samples in this study (Table 4). Total petroleum hydrocarbons in the lube oil range were detected at Station 0006 during the first storm grab event and the first storm composite event and at Station 0015 during the first storm grab event. For these samples, the TPH concentration was equal to or less than 0.3 mg/L (just higher than the laboratory detection limit of 0.2 mg/L). Visible sheen was frequently observed at Station 0006 throughout the course of the study. Oil and grease and visible sheen were not discussed in previous studies.

4.1.8 Field Measurements: Temperature, Dissolved Oxygen, pH, and Conductivity

Continuous temperature at Station 1 ranged from a maximum of 17C in June 2002 to a minimum of 3C in December 2001. Temperature data collected during sampling events (Table 6) and as part of the continuous monitoring at Station 1 (Appendix D) were below Ecology's 18C criteria (WAC 173-201A-030). However, National Marine Fisheries Service (NMFS) recommends a maximum temperature of 13.8 C for salmon bearing streams (NMFS 1996). This maximum was exceeded only once during sampling events, at Station 0016 during the SG#1 sampling event. The continuous monitoring data at Station 1 indicated that temperature was frequently higher than 13.8 C during the summer months. As found in the METRO baseflow study and in the monthly Hylebos Creek Stream Team samples, temperature is not a major concern in the East Hylebos basin or in the North or West Forks of Hylebos Creek when compared to Ecology's standard. However, temperature is a concern when considered in comparison to NMFS more stringent guidelines for salmon bearing stream.

Dissolved oxygen data collected during baseflow sample collection were above Ecology's minimum 8 mg/L criterion (WAC 173-201A-030) except at Station 0006 during the dry season baseflow event when the dissolved oxygen level was 8 mg/L (Table 4). Station 0006 water was stagnant at this time, which contributed to the decreased dissolved oxygen level. These results are similar to the results of the METRO baseflow sampling at Station 0001 and the Hylebos Creek Stream Team sampling in the East Hylebos Creek basin.

Water quality data collected during this study indicated that pH was generally within Ecology's criteria that pH be within the range of 6.5 to 8.5. The only sample that did not meet Ecology's criteria was at Station 0006 during the first storm grab sampling event (pH = 6.4) (Table 4). These results are similar to those from the METRO baseflow study and the Hylebos Creek Stream Team monitoring where pH was usually within state water quality criteria.

Conductivity measurements are presented in Figure 12. Conductivity was generally higher during baseflow events. Station 1 tended to have the highest conductivity values with a maximum conductivity of 0.208 mS/cm. The relatively consistent low conductivity values at Station 0006 may indicate groundwater is a lesser proportion of flow than in other reaches.

4.2 MACROINVERTEBRATES – EAST HYLEBOS B-IBI SCORE AND COMPARISON TO NORTH AND WEST FORKS OF HYLEBOS CREEK DATA

Based on the B-IBI result, overall biological integrity of East Hylebos Creek is a about 3/4 of Rock Creek (tributary to Cedar River on left bank), a reference stream for the Puget Sound Lowlands B-IBI, which typically scores in the high 40's (Taylor Associates, Inc. 2000). The macroinvertebrate community at Rock Creek is reflective of a healthy, minimally disturbed watershed. As a regional reference station, Rock Creek reflects the biological conditions that undisturbed streams in this region can support. More disturbed streams have lower B-IBI scores (Fore 1999; Fore et al. 1996, Kleindl 1995).

The B-IBI score of the ravine reach of East Hylebos Creek was reflective of habitat conditions at the site as measured by the overall Rapid Bioassessment Protocol (RBP) habitat scores conducted in conjunction with the macroinvertebrate collection. The ravine reach of East Hylebos Creek scored a 150 out of 200 possible points on the RBP Habitat Assessment Field Data Sheet (Appendix F). The ravine reach scored in the marginal category for channel flow status and in the suboptimal category for several habitat parameters including epifaunal substrate/available cover, embeddedness, velocity/depth regime and sediment deposition.

In general, increased anthropogenic disturbance upstream of the macroinvertebrate sample may have caused the lower B-IBI in this stream. The habitat in the ravine reach where macroinvertebrates were sampled is not largely impacted by land-uses in the adjacent corridor. The steep slopes of the ravine preclude residential development. However, upstream anthropogenic disturbance may contribute to the marginal and suboptimal categorization of several RBP habitat parameters. Upstream of the ravine reach is a plateau with significant residential and commercial development. Effects of impervious surfaces associated with development in the plateau may also contribute to the marginal categorization of channel flow status and the suboptimal categorization of epifaunal substrate/available cover, embeddedness, and sediment deposition as described in the RBP. Natural sediment deposition from the steep ravine walls may also contribute to the suboptimal categorization of epifaunal substrate/available cover, embeddedness and sediment deposition.

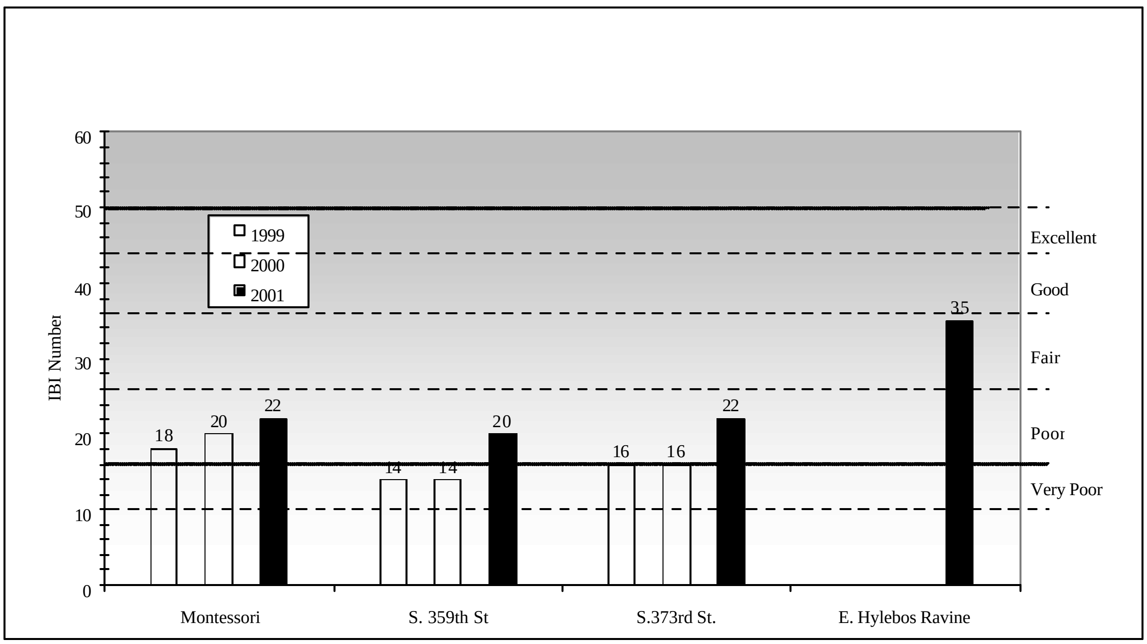


Figure 13. Comparison of IBI scores on North, West and East Forks

The B-IBI value of the 2001 benthic invertebrate sample for the East Hylebos ravine was higher than the B-IBI values of samples collected by the Hylebos Stream Team in conjunction with the City of Federal Way at three locations on the North and West Fork of Hylebos Creek in 1999, 2000, and 2001 (personal communication, Milesi 2001) (Figure 13). Not enough data has been collected to show statistical significance. The reasons for the different scores could be related to habitat, water quality, or sample collection location. The three locations where macroinvertebrate samples were collected by the Stream Team were: (1) the West Hylebos branch at 373rd St., (2) the North Fork of West Hylebos at S. 359th St., and (3) the West Fork of West Hylebos at Montessori School. These samples were collected and analyzed by a laboratory in a comparable manner as the sample from this study (Hylebos Creek Stream Team 2000).

4.3 STREAM HABITAT

The *King County Sensitive Areas Map Folio* (King County 1990b) identifies East Hylebos Creek as a class 2 stream with salmonids in the main branch (tributary 0006) downstream of Station 0006, in tributary 0015 downstream of Station 0015, and in tributary 0016. The upstream reaches of tributary 0006 and tributary 0015 are unclassified. The mainstem of East Hylebos Creek (tributary 0006) is a perennial stream with a low flow of approximately 1 cfs during the summer months based on flow data from Station 1 during this study. Salmonids inhabiting East Hylebos Creek include coho salmon (*Oncorhynchus kisutch*), chum salmon (*Oncorhynchus keta*), and cutthroat trout (*Oncorhynchus clarki*) (King County 1990b). During the stream survey numerous juvenile coho salmon and cutthroat trout were observed.

The results of the stream habitat survey were used to document environmental baseline of the ravine reach of East Hylebos Creek using criteria developed by the National Marine Fisheries Service (NMFS 1996, Appendix I). Diagnostic indicators listed in the NMFS (1996) matrix method are summarized in Table 11. Most environmental baseline indicators for East Hylebos Creek in the ravine reach are categorized as “At Risk”. In isolation, the ravine reach appears to contain good salmonid habitat but the indicators in the pathway for watershed conditions are not properly functioning due to urbanization in the watershed. This suggests that the instream conditions may not be maintained over time.

4.3.1 Comparison to Results from *Current and Future Conditions Report*

The *Current and Future Conditions Report* (King County 1990a) describes the ravine reach as “Moderately good habitat structure; numerous patches of good spawning and rearing habitat (riffles with appropriately sized gravels and small pools). Generally adequate large organic debris (LOD); good canopy and bank vegetation.” The results of the 2001 stream survey concur with these findings. The Hylebos-Lower Puget Sound Drainage Basin Salmonid Habitat Report (HSHR) (Ridge-Cooney 1989) also describes the habitat in the ravine reach. The survey forms used in HSHR are not similar to present forms but in general the findings are consistent. The HSHR found vegetative bank cover, overhead canopy, fish habitat, artificial bank protection, streambank stability, and substrate consolidation all to be functioning properly (a score of 1 or 2 out of 5). The only category to receive a low score was channel capacity which received a 4 (channel barely appears to contain present peak flows) out of 5.

Table 11. NMFS Environmental Baseline Checklist for the Ravine Reach of East Hylebos Creek. Numbers in the table refer to notes at bottom of table.

Indicators	Ravine Reach Environmental Baseline		
	Properly Functioning	At Risk	Not Properly Functioning
Water Quality			
Temperature		**1**	
Sediment/Turbidity		**2**	
Chem. Cont./Nut.		**3**	
Habitat Access			
Physical Barriers	**4**		
Habitat Elements			
Substrate		**2**	
LWD		**5**	
Pool Frequency	**6**		
Pool Quality		**7**	
Off-Channel Habitat		**8**	
Refugia			**9**
Channel Cond. & Dyn.			
Width/Depth Ratio			**10**
Streambank Cond.	**11**		
Floodplain Connectivity	**12**		
Flow/Hydrology			
Peak/Base Flows			**13**
Drainage Increase		**14**	
Watershed Conditions			
Road Density & Loc.		**15**	
Disturbance History			**16**
Riparian Reserves		**17**	

[1] Peak observed summer temperature 16C (61F) in June 2001.

[2] Gravels and cobbles dominant. However, embeddedness 25% throughout reach. Wolman pebble counts revealed ~16% of substrate <2 mm. Low turbidity at baseflows.

[3] Elevated nutrient, TSS, and fecal coliform levels observed at Station 1.

[4] No barriers to fish migration in ravine reach.

[5] Large woody debris is abundant (259 pieces/mile). However, does not meet NMFS criteria of >24" dia. And >50' length. Potential LWD recruitment is high.

[6] Pool frequency (63 pools/mile) meets standards (47 pools/mile-30' BKF width). LWD recruitment high.

[7] No pools > 1 meter. Median pool quality index 3. However, pools generally had good cover.

[8] A few backwater pools and high energy side-channels present. No off channel habitat in the form of ponds. Ravine slopes constrain off channel habitats.

[9] Adequate habitat refugia do not exist.

[10] Channel BNKF width/BNKF depth ratio 20. (30' mean BNKF width and ~1.5' BNKF depth)

[11] Streambanks stable.

[12] Existing off-channel habitats are connected.

[13] Urbanization in upstream reaches has altered hydrograph with changes in peak and base flows and flow timing.

[14] No roads in ravine floodplain. A dirt road upslope on left bank. Watershed has signif. drainage network increase.

[15] No valley bottom roads in ravine reach but upper watershed has >3 miles/miles^2.

[16] Urbanization has disturbed the watershed.

[17] Riparian reserve in ravine excellent. Riparian reserve in watershed is fragmented and poorly connected.

4.3.2 Discussion of Relevance/Accuracy of EDT Input Data

The stream survey collected information relevant to several attributes used in the EDT analysis (Pierce County, June 2001) (Table 12). EDT analysis is currently being conducted by Pierce County for all of WRIA-10, including the Hylebos Basin. The EDT is a habitat-based procedure for relating environmental conditions to the performance of salmon populations. EDT consists of 44 attributes. Of these attributes, only those presented in Table 12 are relevant to the stream survey results from this study.

Table 12. Comparison of EDT Scores and Habitat Survey

EDT Attribute	EDT Attribute score/description	Macroinvertebrate and Stream Habitat Survey
Benthos	macroinverts abundant but 1-2 EPT families not present	BIBI scored 9 out of possible 15 for EPT richness
Minimum wetted width	10'	10'
Confinement-natural	reach moderately confined by natural channel features	channel confined by ravine
Embeddedness	>25 and < 50 %	~25%
Fine sediment	< 6% fines < 0.85 mm	Pebble counts ~16% < 2 mm
Gradient	>0.10% and <0.5%	~3%
Habitat Type		
backwater pools	5%	11%
beaver ponds	0%	0%
large cobble/boulder riffles	0%	0%
off channel[1]	0%	5% (estimate)
pool tailouts/glides[1]	15%	7% glide 3% pool tailout (estimate)
primary pools[2]	15%	35%
small cobble/gravel riffles	65%	50%
Obstructions to fish migration	none	none
Riparian function	50-75% of functional attributes present	good-wide/dense riparian buffer 80%
Wood	few pieces of large wood	38 pieces of > 50cm diameter

[1] Off channel and pool tailouts not measured in stream survey.

[2] Includes backwater pools for stream survey. Also includes pool tails outs.

Shaded cells represent attributes where the difference between the EDT score and results of the habitat survey.

The main incompatibility between results of this study and the EDT attributes was that different stream reach partitioning is used in the EDT than in this study. The reach that the EDT ratings cover (hyle –3) is greater than that covered in the stream survey. Hyle-3 comprises two distinct reaches based on gradient. From the beginning of hyle-3 at the confluence of the East and West forks to the wetland at the beginning of the ravine reach is a low gradient depositional area with a wide floodplain. Upstream of the wetland the ravine reach has a more confined floodplain due to ravine slopes and habitat features consistent with greater gradients and hence, higher energy. The habitat survey conducted as part of this study was only the section upstream of the wetland.

In addition, the criteria used to rank some attributes in the EDT are different than protocols used in the stream survey. The EDT fine sediments attribute categorizes fines as <0.85 mm. The Wolman pebble count used in the stream survey does not categorize fine sediments that small. The smallest ranking on Wolman is <2mm. In addition, the EDT lists percentages for habitat types including off channel and pool tailouts not inventoried as part of the stream survey. The EDT criterion for LWD is also different than used in the stream survey. Therefore, the EDT ratings criteria are not the exact same as data collection methods used in the stream survey.

However, although the criteria used for the EDT scores differed from some of those used in this study, the information is relatively comparable. The stream survey findings from this study are compared with the EDT findings in Table 12. As noted earlier, the largest incompatibility between the EDT analysis scores and this study was the sectioning of the stream reaches with only the upstream reach of hyle-3 (the EDT reach) surveyed as part of this study. In general, it appears the EDT scorings are consistent with the stream survey findings from this study in that the scores are similar to what was observed in the field. Attributes for which there was a difference are highlighted in Table 12. The categories which indicated differences between the stream habitat survey and the EDT scores were: Gradient, Habitat Type – backwater pools, off channel, pool tailouts/glides, primary pools, small cobble/gravel riffles, and Riparian function. Where there were differences, they were most likely due to the differences in the upstream reaches. The significance of these differences to the EDT score should be evaluated to ensure the appropriateness of the EDT score, and the EDT scores adjusted for the parameter if necessary.

The results of the water quality and flow monitoring from this study are also comparable to some EDT attributes (even if the data was not collect in a matter directly comparison to EDT criteria). Although the scope of this report is limited to the comparison of the stream habitat survey and EDT attributes, it appears that the water quality and flow criteria EDT scores for hyle-3 (i.e., Dissolved oxygen, Hydrologic regime – natural, Icing, Metals – in water column, Nutrient enrichment, Temperature – daily maximum (by month), Temperature – daily minimum (by month), and Turbidity) are appropriate for the ravine reach of East Hylebos Creek based on data collected as part of this study.

EDT attributes that were not addressed by this study include: Alkalinity, Bed scour, Maximum width (ft) – wetted channel (monthly average), Confinement – Hydromodifications, Fish community richness, Fish pathogens, Fish species introductions, Flow – change in interannual variability in high flows, Flow changes in interannual variability in low flows, Flow – intra daily (diel) variation, Flow – Intra annual flow pattern, Harassment, Hatchery fish outplants, Hydrologic regime – natural, Hydrologic regime – regulated, Metals/Pollutants – in sediment/soils, Miscellaneous toxic pollutants – water column, Predation risk, Salmon Carcasses, Temperature – spatial variation, and Water withdrawals.

5.0 CONCLUSIONS

The following are conclusions for the East Hylebos Creek 2001 Monitoring Program:

- Salmonid habitat is relatively good in the ravine reach of East Hylebos Creek. Salmon habitat still exists and salmon and trout persist in the reach. However, salmon habitat is at risk for degradation due to degraded water quality, changing substrate, loss of LWD, decreased pool quality and off channel habitat and increased drainage from continuing upstream urbanization.

- The minimum baseflow observed during the summer months near the mouth of East Hylebos Creek (Station 1) was approximately 1 cfs. The upstream branches were dry during portions of the summer. Flooding occurred at Station 1 where the creek has historically overtopped the road.

- Of the water quality parameters evaluated as part of this study, fecal coliforms, total phosphorus, copper and zinc toxicity, and total suspended solids are parameters of concern in the East Hylebos watershed. Fecal coliform levels exceeded Ecology water quality criterion in almost all samples collected. Total phosphorus exceeded EPA recommended criterion for almost all samples except those collected during wet season baseflow conditions. Total suspended solids exceeded King County's recommended basin threshold level during storm events at Station 1. Although not directly comparable due to duration of sample collection period, Ecology water quality criteria for dissolved zinc and copper were exceeded during storm events at Station 0006.

- Temperature, dissolved oxygen, and pH levels are within Ecology criteria. However, temperature exceeds NMFS recommendations during the summer months. Water quality data was not directly comparable to data collected by the Stream Team due to the differences in collection methods and documentation.

- Water quality data from this study does not seem to be substantially different from data presented in the *Current and Future Conditions Report* (1990) with the exception that fecal coliform concentrations may have increased.

- The B-IBI score (35 out of 50) indicates some impact of urbanization but were relatively good compared to other sites sampled on the North and West Forks of Hylebos Creek.

- It appears that the ravine reach channel morphology has not undergone significant changes since the *Current and Future Conditions Report*. Channel structure at some localized sections of the upstream reaches is dynamic as shown by the significant change in channel morphology observed at Station 0016.

- All evaluated tributaries of East Hylebos Creek evaluated indicate that the creek continues to be impacted by urbanization in the watershed.

6.0 RECOMMENDATIONS

The following are recommendations for possible future activities related to East Hylebos Creek based on the monitoring program objectives presented in Section 1.1 Project Description:

- Continue activities by local jurisdictions and volunteers to protect resources within the ravine reach of East Hylebos Creek.
- The following are activities that could be conducted with the assistance of volunteers under King County's or another organization's guidance or through such programs as King County's Salmon Watcher program. The purpose of these activities would be to generate community interest in and ownership of the creek and collect data that King County could be use for evaluating conditions in the watershed.
  - Initiate monthly temperature readings at the four stations, especially during summer months when temperature is of greatest concern.
  - Continue monthly crest gage readings at four stations
  - Continue annual macroinvertebrate sampling in the ravine reach
  - Initiate spawner surveys in the ravine reach to document salmon spawning timing and distribution.
- Continue water quality monitoring focusing on pollutant of concern and source identification as suggested by the water quality results. For example, more targeted sampling for total phosphorus and TSS at and upstream of Station 1 during storm events. Investigation of fecal sources is another potential focus of additional water quality monitoring.
- Flow monitoring could be improved by conducting more flow measurements to expand the rating curve ranges, increase their accuracy, and to update the curves to reflect changes in station morphology over time. A location for flow monitoring for Station 0006 would need to be established. At Station 1, installation of the continuous stage recorder several inches above the stream bed would prevent the sediment accumulation which interfered with measurements for this project.
- Establish channel cross sections to evaluate changes in channel morphology over time, especially at flow monitoring locations and in specific areas of interest (e.g., the ravine reach).
- King County should consider establishing an ongoing monitoring program for the East Hylebos basin to extend the data set over time to improve the understanding of current conditions and trends in the basin. Data from a long-term monitoring effort could be used to support updates to the EDT watershed analysis and conservation planning actions.

- Consistency between EDT attribute values and other habitat model criteria and stream survey protocols, such as King County's, is needed. For the East Hylebos ravine reach the EDT reach hyle-3 should be divided into two reaches representing different stream types.

- Review results from laboratory analysis (nutrients and metals) of water quality samples collected as part of this study but not discussed in the report, especially nitrate-plus-nitrite nitrogen results. Nitrate-plus-nitrogen was a pollutant of concern discussed in previous studies.

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